SOIL SURVEY OF

Parmer County, Texas

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Texas Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1967–72. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Parmer County Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, woodlands, and wildlife areas; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Parmer County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside, and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page number of the capability unit and the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the range sites.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for dwellings and industrial buildings and for recreation areas in the sections "Engineering Uses of the Soils" and "Recreational Development."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Parmer County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication and in the section "General Nature of the County."

Cover: Irrigated grain sorghum ready for harvest on Acuff loam, 0 to 1 percent slopes. Grain elevator and the city of Bovina are in the background.

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SOIL SURVEY OF PARMER COUNTY, TEXAS

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE TEXAS AGRICULTURAL EXPERIMENT STATION

PARMER COUNTY is on the western edge of the Texas Panhandle (fig. 1). It is in the southern part of the smooth tableland known as the High Plains which extend from Texas into Canada. This tableland is broken by playa basins and entrenched draws. The county has an area of 549,760 acres, or 859 square miles. Elevation ranges from about 4,440 feet at a point 2.1 miles south of the northwest corner of the county to 3,770 feet where Running Water Draw leaves the county on the east.

Irrigated grain sorghum, cotton, corn, and wheat are the main crops. Grain sorghum and wheat are also dryfarmed, and nearly all of the dryfarmed soils are in the northwestern part of the county. Parmer County is the leading producer of grain sorghum in Texas. A large acreage of irrigated vegetables and sugar beets is also grown.

Beef production is an important enterprise in the county, and livestock operations include cow-calf and stocker cattle enterprises. Stocker cattle are mainly grazed on wheat in winter, but thousands of cattle are fattened each year in feedlots, where vegetable and sugar beet byproducts, hay, silage, and locally grown grain sorghum are used as feed. Feedlot operations have created an increased interest in stocker cattle. Seven commercial feedlots are located in the county. The feedlots range in capacity from 7,500 to 60,000 head. An increased number of livestock raisers keep calves from their herds, run them as stockers if forage is available, and then place them in nearby feedlots.

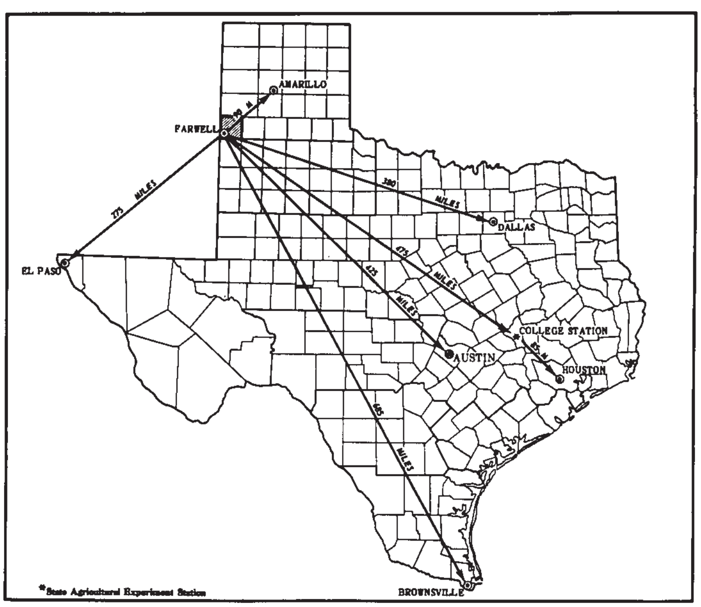

Figure 1.—Location of Parmer County in Texas.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Parmer County, where they are located, and how they can be used. The soil scientists went into the county knowing they would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Friona and Olton, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Acuff loam, 3 to 5 percent slopes, is one of several phases within the Acuff series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a map-

ping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Parmer County: soil complex and undifferentiated group.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Estacado-Posey complex, 3 to 5 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. Bippus and Spur soils, frequently flooded, is an example.

While a soil survey is in progress, samples of soil are taken as needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants, and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Parmer County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is useful as a general guide in managing a watershed or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The six associations in Parmer County are discussed in this section. The terms for texture used in the title for several of the associations apply to the texture of the surface layer. For example, in the title of association 1, the words, "clay loams," refer to the texture of the surface layer.

1. Olton association

Nearly level to gently sloping, noncalcareous, moderately slowly permeable clay loams on uplands

This association makes up about 54 percent of the county. It is about 81 percent Olton soils and 19 percent minor soils. Most of the soils are nearly level, but in some areas gently sloping soils are around playas (fig. 2).

Olton soils have a surface layer of brown clay loam about 9 inches thick. The next layer to a depth of 28 inches is brown and reddish-brown clay loam. Below this is 22 inches of yellowish-red clay loam. The next layer to a depth of about 76 inches is pinkish-white clay loam.

Minor in this association are Acuff, Amarillo, Berda, Estacado, Lipan, Pullman, Randall, and Tulia soils. Lipan soils are on benches around playas, and Randall soils are on playa bottoms. The other soils are in small areas scattered throughout the association.

This association is used mostly for crops. Most cultivated areas are irrigated, mainly by surface methods. Alfalfa, corn, cotton, grain sorghum, soybeans, and wheat are the main crops. Many areas of Olton soils are used for production of vegetables. Small areas of gently sloping soils are used for grass. Pheasant flourish in grain fields if stalks are left as cover.

2. Acuff association

Nearly level to gently sloping, noncalcareous, moderately permeable loams on uplands

This association makes up about 16 percent of the county. It is about 70 percent Acuff soils and 30 percent minor soils. This association lacks prominent features, but it is characterized by a few slight rises and many circular playas in which water accumulates (fig. 3). Almost a third of the acreage is gently sloping and is on the upper rims of playa depressions.

Acuff soils have a surface layer of brown loam about

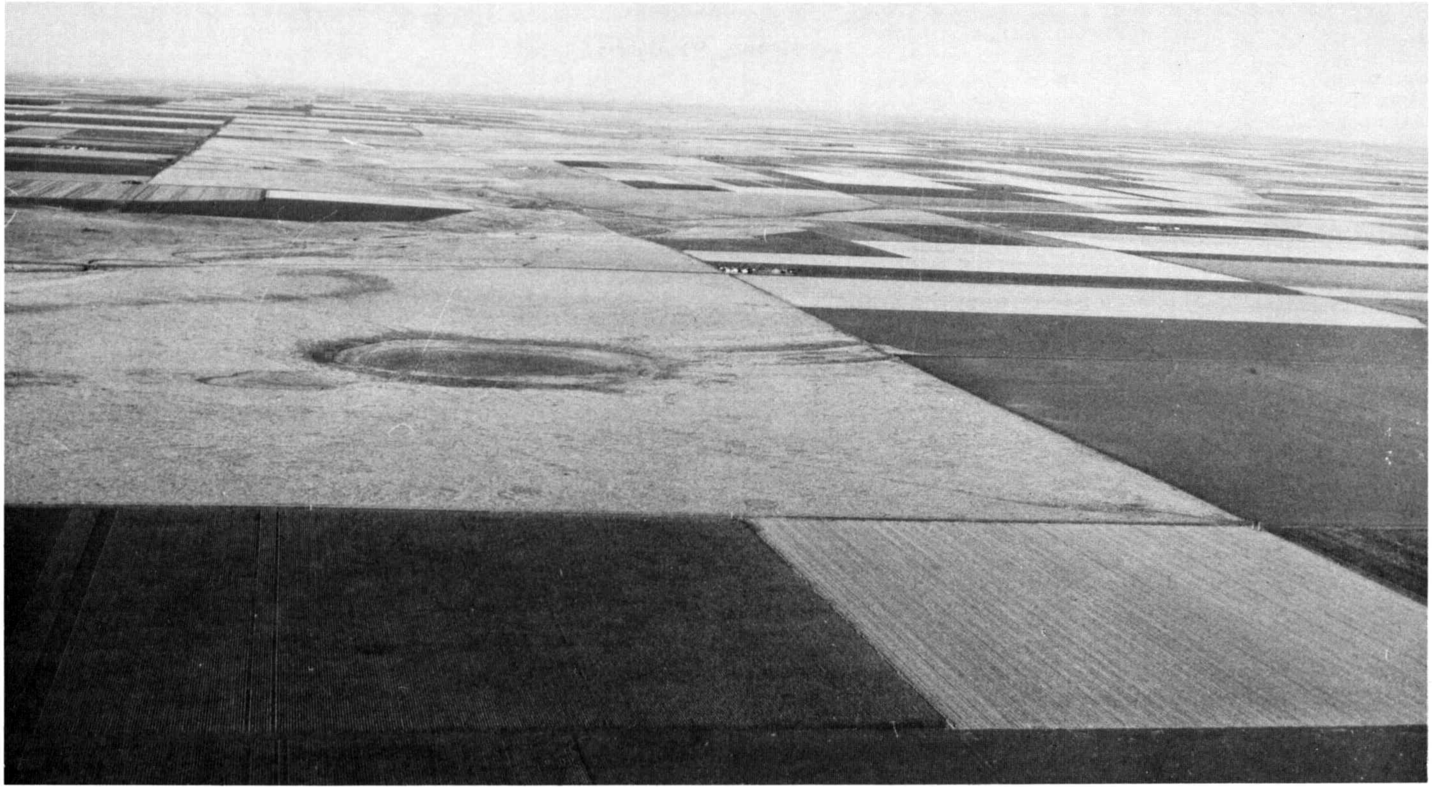

Figure 2.—**Nearly level soils and a playa basin in the Olton association.**

11 inches thick. Below this is about 5 inches of brown sandy clay loam. The next layer is yellowish-red and light reddish-brown sandy clay loam to a depth of 52 inches. Below this to a depth of about 80 inches is pink sandy clay loam.

Minor in this association are Amarillo, Estacado, Friona, Olton, and Randall soils. Amarillo and Estacado soils are in sloping areas around the playas, and Friona and Olton soils are in smooth areas scattered throughout the association. Randall soils are on playa bottoms.

About 90 percent of this association is cultivated, and most areas are irrigated. Cotton, corn, grain sorghum, and wheat are the main crops. Alfalfa, soybeans, and vegetables are grown in some areas. Grain fields provide cover and food for pheasant and are seasonal feeding grounds for ducks and geese.

3. Pullman association

Nearly level to gently sloping, noncalcareous, very slowly permeable clay loams on uplands

This association makes up about 14 percent of the county. It is about 87 percent Pullman soils and 13 percent minor soils. This association lacks prominent features, but it is characterized by a few slight rises and many circular playas in which water accumulates.

Pullman soils have a surface layer of brown clay loam about 9 inches thick. The next layer is brown, reddish-brown, and yellowish-red clay to a depth of 48 inches. Below this to a depth of 89 inches is pink clay over reddish-yellow clay loam.

Minor in this association are Estacado, Lipan, Olton, Randall, and Tulia soils. Estacado, Olton, and Tulia soils are on side slopes and in broad, smooth areas, Lipan soils are on low benches, and Randall soils are on playa bottoms.

Most of the dryfarmed areas and many of the irrigated areas in the county are in this association. Pullman soils are well suited to surface irrigation. The soils are droughty when dryfarmed. Alfalfa, corn, cotton, grain sorghum, vegetables, and wheat are the main crops. Pheasant and waterfowl use some of the wasted grain in fall and winter. Many areas in the association can be used for ponds for fish production if water is available.

4. Amarillo association

Nearly level to gently sloping, noncalcareous, moderately permeable fine sandy loams on uplands

This association makes up about 8.5 percent of the county. It is about 61 percent Amarillo soils and 39 percent minor soils. This association is on a plain that is smooth except for playa depressions. About a fifth of the acreage is gently sloping and is on rims around playas.

Amarillo soils have a surface layer of reddish-brown fine sandy loam about 9 inches thick. Below this is yellowish-red sandy clay loam to a depth of 44 inches. The next layer between the depths of 44 and 56 inches is pink sandy clay loam that is high in calcium carbonate. Below this to a depth of 102 inches is reddish-yellow sandy clay loam.

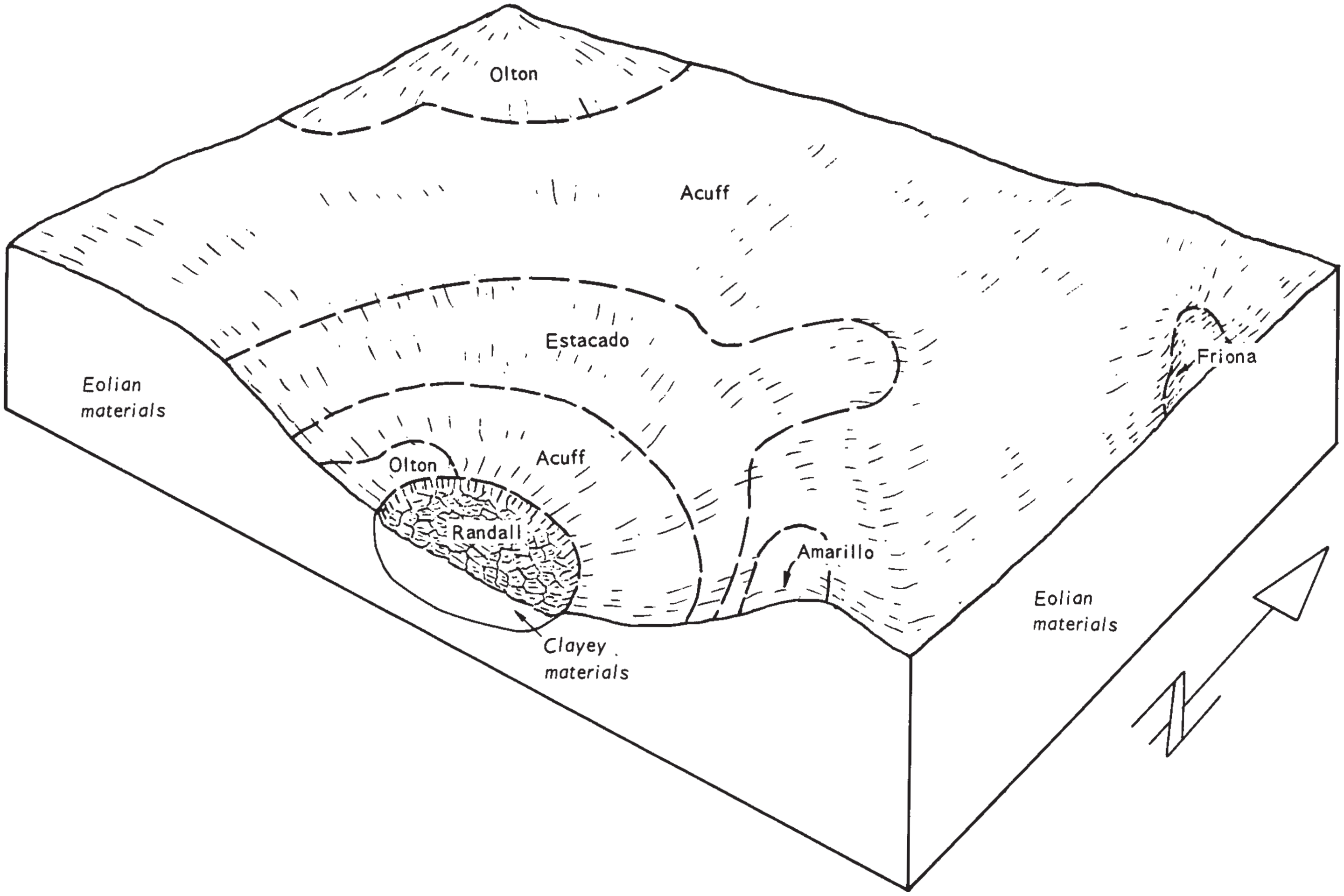

***Figure 3.*—Typical pattern of soils and parent material in the Acuff association.**

Minor in this association are Acuff, Arvana, Bippus, Estacado, Olton, Posey, Randall, Tulia, and Zita soils. Acuff, Arvana, Estacado, Olton, and Posey soils are in the smooth areas. Also, Estacado, Posey, and Tulia soils are on side slopes of drainageways and playas. Bippus soils are on alluvial bottoms of drainageways. Randall soils are on playa bottoms, and Zita soils are on benches around depressions.

About 90 percent of this association is cultivated. Most areas are irrigated. Alfalfa, castorbeans, corn, cotton, grain sorghum, soybeans, and wheat are the main crops.

5. Berda-Estacado-Bippus association

Nearly level to sloping, noncalcareous to calcareous, moderately permeable loams and clay loams on sides and bottoms of draws

This association makes up about 6.5 percent of the county. It is about 19 percent Berda soils, 18 percent Estacado soils, 16 percent Bippus soils, and 47 percent minor soils.

Berda soils have a surface layer of brown loam about 6 inches thick. The next layer is brown and light-brown loam to a depth of 27 inches. Below this is light reddish-brown loam about 9 inches thick. The underlying material is reddish-brown fine sandy loam to a depth of 63 inches.

Estacado soils have a surface layer of dark grayish-brown and brown clay loam about 13 inches thick. The next layer is brown and light-brown clay loam to a depth of 28 inches. Below this is about 15 inches of pink clay loam that is high in carbonates. The next layer is light-brown clay loam to a depth of 75 inches. Below this to a depth of about 90 inches is reddish-yellow clay loam.

Bippus soils have a surface layer of brown, very dark grayish-brown, and dark grayish-brown clay loam about 19 inches thick. The next layer is brown clay loam about 47 inches thick.

Minor in this association are Acuff, Amarillo, Kimbrough, Likes, Mobeetie, Olton, Posey, Potter, Pullman, Randall, Spur, and Tulia soils. Spur soils and a few small playas that consist of Randall soils are on the bottoms of draws. The other soils are on side slopes of draws.

This association is used mostly as range. Some areas of Bippus soils are used for irrigated crops. Although some of the best range areas in the county are in this association, only a few areas are used entirely for range. Draws in this association have potential as sites

for dams, which could store limited amounts of water. This association has some potential as wildlife habitat for predators, furbearers, rodents, quail, and other small birds and mammals.

6. *Estacado-Tulia association*

Nearly level to gently sloping, calcareous, moderately permeable clay loams to loams on uplands

This association makes up about 1 percent of the county. It is about 58 percent Estacado soils, 15 percent Tulia soils, and 27 percent minor soils. About a third of the acreage is gently sloping.

Estacado soils have a surface layer of dark grayish-brown and brown clay loam about 13 inches thick. The next layer is brown and light-brown clay loam to a depth of 28 inches. Below this is about 15 inches of pink clay loam that is high in carbonates. Next is light-brown clay loam to a depth of 75 inches. Below this to a depth of about 90 inches is reddish-yellow clay loam.

Tulia soils have a surface layer of grayish-brown loam about 9 inches thick over light brownish-gray clay loam about 8 inches thick. The next layer is very pale brown and reddish-yellow clay loam to a depth of 63 inches. Below this to a depth of about 94 inches is yellowish-red clay loam.

Minor in this association are Acuff, Olton, and Posey soils, all of which are on smooth plains.

This association is used mostly for crops. Most cultivated areas are irrigated. Alfalfa, corn, cotton, grain sorghum, soybeans, and wheat are the main crops. This association has potential as wildlife habitat, mostly for pheasant.

Descriptions of the Soils

This section describes the soil series and mapping units in Parmer County. Each soil series is described in detail, and then, briefly, each mapping unit in that series is described. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of each series description is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, the differences are stated in the description of the mapping unit, or they are differences that are apparent in the name of the mapping unit. Soil colors in this section are expressed both in words and in Munsell color notations and are for dry soil unless otherwise stated. The description of each mapping unit contains suggestions on how the soil can be managed.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and range site in which the mapping unit has been placed. The page for the description of each capability unit and range site can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*6*).[1]

[1] Italic numbers in parenthesis refer to Literature Cited, page 60.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Acreage	Percent	Soil	Acreage	Percent
Acuff loam, 0 to 1 percent slopes	59,260	10.8	Friona loam, 0 to 1 percent slopes	4,290	0.8
Acuff loam, 1 to 3 percent slopes	28,660	5.2	Kimbrough loam, 1 to 5 percent slopes	800	.1
Acuff loam, 3 to 5 percent slopes	2,740	.5	Likes loamy fine sand, 1 to 8 percent slopes	790	.1
Amarillo fine sandy loam, 0 to 1 percent slopes	23,340	4.3	Lipan clay, depressional	1,150	.2
Amarillo fine sandy loam, 1 to 3 percent slopes	8,840	1.6	Mobeetie fine sandy loam, 0 to 3 percent slopes	770	.1
Amarillo fine sandy loam, 3 to 5 percent slopes	1,150	.2	Olton clay loam, 0 to 1 percent slopes	227,840	41.4
Arvana fine sandy loam, 0 to 1 percent slopes	5,450	1.0	Olton clay loam, 1 to 3 percent slopes	27,440	5.0
Berda loam, 3 to 5 percent slopes	2,080	.4	Posey fine sandy loam, 0 to 1 percent slopes	2,070	.4
Berda loam, 5 to 8 percent slopes	4,080	.7	Posey fine sandy loam, 1 to 3 percent slopes	3,760	.7
Bippus fine sandy loam, 0 to 1 percent slopes	1,540	.3	Posey-Berda complex, 5 to 8 percent slopes	2,710	.5
Bippus clay loam, 0 to 1 percent slopes	4,100	.7	Potter loam, 3 to 12 percent slopes	1,560	.3
Bippus clay loam, 1 to 3 percent slopes	980	.2	Pullman clay loam, 0 to 1 percent slopes	69,380	12.6
Bippus and Spur soils, frequently flooded	2,580	.5	Pullman clay loam, 1 to 3 percent slopes	3,380	.6
Estacado clay loam, 0 to 1 percent slopes	14,260	2.6	Randall clay	9,840	1.8
Estacado clay loam, 1 to 3 percent slopes	22,310	4.1	Tulia loam, 0 to 1 percent slopes	1,120	.2
Estacado-Posey complex, 3 to 5 percent slopes	6,570	1.2	Tulia loam, 1 to 3 percent slopes	1,820	.3
			Tulia-Potter complex, 1 to 5 percent slopes	1,980	.4
			Zita loam, 0 to 1 percent slopes	1,120	.2
			Total	549,760	100.0

Acuff Series

The Acuff series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils on smooth upland plains. These soils formed in eolian deposits.

In a representative profile the surface layer is brown loam about 11 inches thick (fig. 4). Below this is brown sandy clay loam about 5 inches thick. The next layer is yellowish-red and light reddish-brown sandy clay loam about 36 inches thick. Below this to a depth of about 80 inches is pink sandy clay loam.

Acuff soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is slow to medium.

These soils are well suited to native grass or to row crops. They can be used for many kinds of irrigated truck crops. Cotton, corn, grain sorghum, wheat, vegetables, soybeans, and alfalfa are the main crops.

Representative profile of Acuff loam, 0 to 1 percent slopes, 2 miles north of Farwell on a county road on New Mexico State line and 1 mile east on a field road, 40 feet east and 100 feet north of the southwest corner of sec. 45, blk. A:

A11—0 to 4 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak, very coarse, prismatic structure parting to weak, fine, subangular blocky and granular; somewhat platy structure in top ½ inch; hard, friable, slightly plastic; many fine roots; many fine and very fine pores and few medium pores; few worm casts; neutral; clear, smooth boundary.

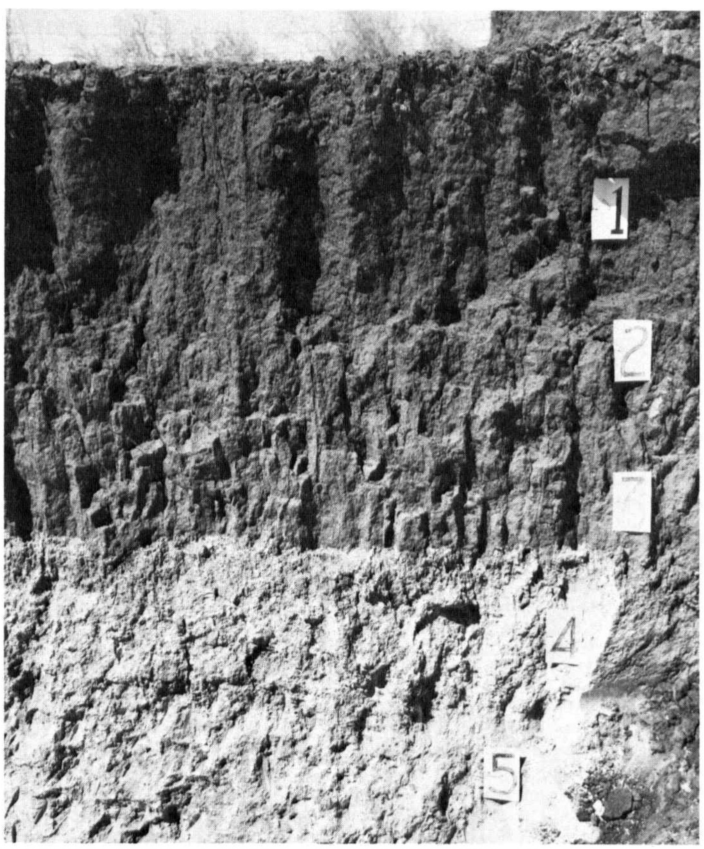

Figure 4.—**Profile of Acuff loam showing the layer of calcium carbonate accumulation below a depth of about 36 inches.**

A12—4 to 11 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate, coarse, prismatic structure parting to weak, fine and very fine, subangular blocky and granular; hard, friable, slightly sticky and plastic; many fine roots; many very fine and fine pores and common medium pores; common worm casts; mildly alkaline; clear, smooth boundary.

B21t—11 to 16 inches, brown (7.5YR 4/2) sandy clay loam, dark brown (7.5YR 3/2) moist; moderate, coarse, prismatic structure parting to weak, fine, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and common medium pores; common worm casts; common, discontinuous, patchy clay films, mostly on faces of prisms; mildly alkaline; clear, smooth boundary.

B22t—16 to 21 inches, yellowish-red (5YR 4/6) sandy clay loam, yellowish red (5YR 3/6) moist; moderate, coarse, prismatic structure parting to weak, fine, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; common worm casts; common patchy clay films, mostly on faces of prisms; mildly alkaline; clear, smooth boundary.

B23t—21 to 28 inches, yellowish-red (5YR 4/8) sandy clay loam, yellowish red (5YR 3/8) moist; moderate, coarse and medium, prismatic structure parting to weak, fine, subangular blocky; very hard, friable, sticky and plastic; common fine roots; many very fine and fine pores and few medium pores; few worm casts; common patchy clay films, mostly on faces of prisms; calcareous in lower part; moderately alkaline; gradual, smooth boundary.

B24t—28 to 40 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, coarse and medium, prismatic structure parting to weak, fine, subangular blocky; very hard, friable, sticky and plastic; few fine roots; many very fine and fine pores and few medium pores; few worm casts; few patchy clay films on faces of prisms; few, fine, calcium carbonate concretions; 1 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, smooth boundary.

B25tca—40 to 52 inches, light reddish-brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; very hard, friable, sticky and plastic; few fine roots; many very fine and fine pores and few medium pores; few worm casts; common patchy clay films on faces of peds, masked in places by calcium carbonate coatings; 5 percent calcium carbonate concretions; 30 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, smooth boundary.

B26tca—52 to 72 inches, pink (5YR 7/3) sandy clay loam, reddish yellow (5YR 6/6) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; very hard, friable, sticky and plastic; few fine pores; few worm casts; few, patchy clay films on faces of peds; few, medium, pinkish-white masses of calcium carbonate; 35 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B27t—72 to 80 inches, pink (5YR 8/4) sandy clay loam, reddish yellow (5YR 6/6) moist; weak, medium, subangular blocky structure; very hard, friable, sticky and plastic; few fine roots; many very fine and fine pores and few medium pores; common patchy clay films on some faces of peds and bridging sand grains; few, fine, calcium carbonate concretions; 12 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The A horizon is 10 to 12 inches thick and is brown, dark brown, or reddish brown. The B21t horizon is 4 to 16 inches thick and is reddish brown or brown. The B21t and B22t horizons are 25 to 35 percent clay. The B22t, B23t, and B24t horizons are reddish brown, yellowish red, or reddish yellow. Secondary carbonates are at a depth of 18 to 28 inches. The B25tca horizon is at a depth of 35 to 60 inches.

The B25tca and B26tca horizons are light reddish brown, pink, or reddish yellow. The content of calcium carbonate is 30 to 60 percent, by volume. The B27t horizon is at a depth of 45 to 75 inches and is pink, reddish yellow, or yellowish red. Calcium carbonates in this horizon range from thin soft coatings and threads to vertical stringers that have cemented concretions.

Acuff loam, 0 to 1 percent slopes (AcA).—This soil is on broad, smooth plains. Most areas range from 10 acres to several thousand acres in size and are irregular in shape. This soil has the profile described as representative of the Acuff series.

Included with this soil in mapping are numerous, small, round spots of Estacado soils that are less than 1 acre to 2 acres in size (fig. 5). Also included are oval spots of Olton soils that are less than 5 acres in size and small areas of Friona soils. These included soils make up less than 2 percent of any mapped area.

This Acuff soil is used mostly for irrigated crops. Small areas are used as range. The hazard of soil blowing is moderate, and the hazard of erosion is slight. A few spots have been damaged by soil blowing.

Irrigation systems are needed that do not increase the hazard of erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Leaving crop residue on the surface helps to control soil blowing and erosion and to conserve moisture. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, fertilizer and high-residue crops help to maintain good tilth. Capability units IIIe–4, dryland, and IIe–1, irrigated; Clay Loam range site.

Acuff loam, 1 to 3 percent slopes (AcB).—This gently sloping soil is in elongated, oval areas 10 to 900 acres in size.

The surface layer is brown loam about 12 inches thick. Below this is brown sandy clay loam about 6 inches thick. The next layer to a depth of about 36 inches is yellowish-red sandy clay loam that is calcareous in the lower part. Below this to a depth of about 72 inches is pink sandy clay loam that is about 45 percent calcium carbonate, by volume. The next layer is pink, calcareous sandy clay loam that is 15 percent calcium carbonate, by volume.

Included with this soil in mapping are small spots of Estacado soils and areas of Amarillo or Olton soils that are a few acres in size.

This Acuff soil is well suited to dryland crops. Many areas are irrigated, and small areas are in native range. The hazards of soil blowing and erosion are moderate.

In dryfarmed areas, terracing and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control soil blowing and erosion and to conserve moisture. Rough surface tillage helps to control soil blowing when crop residue is inadequate.

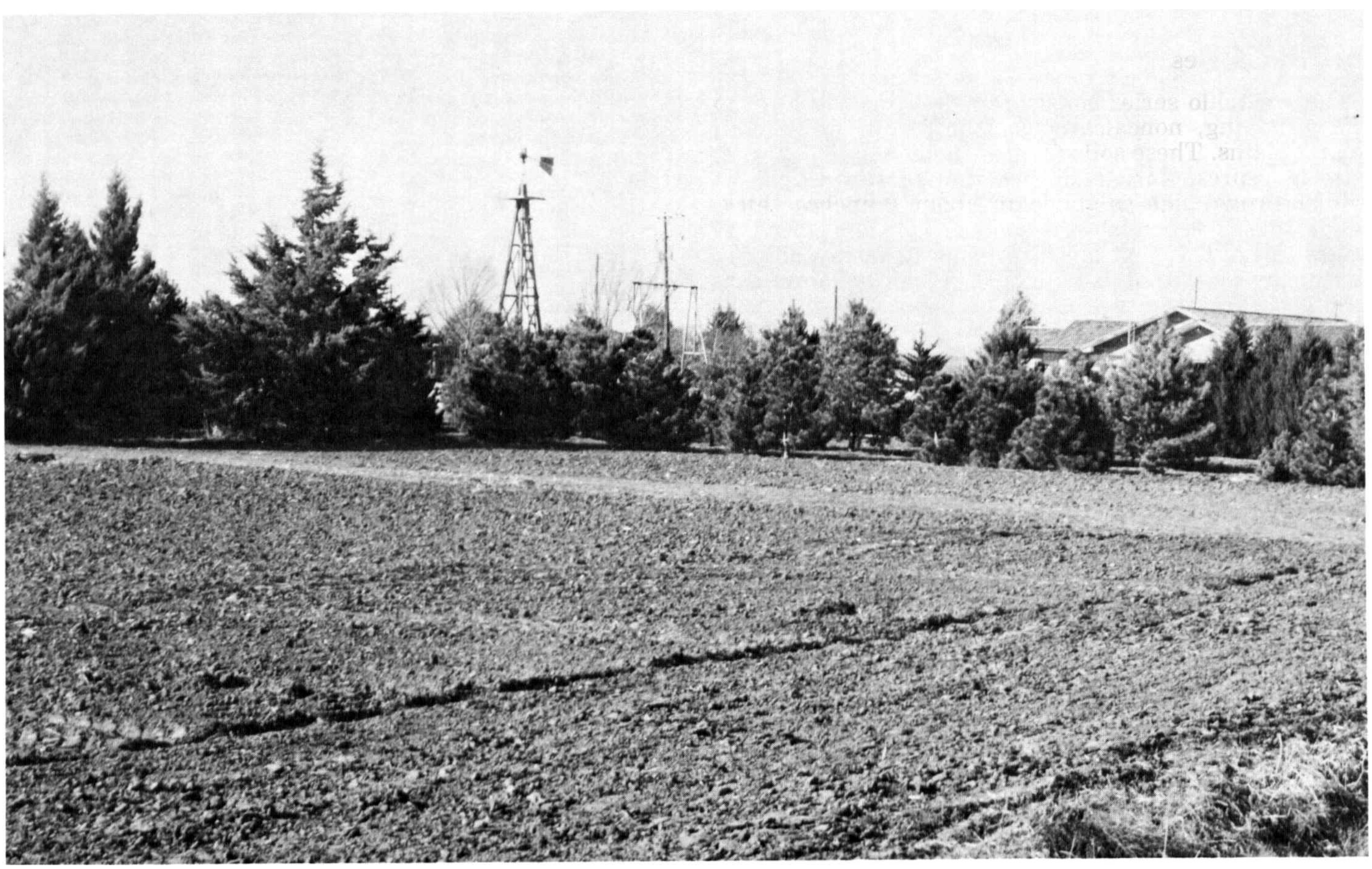

Figure 5.—**Windbreak on Acuff loam, 0 to 1 percent slopes. Included areas of Estacado soils have affected the growth of trees in the center of the windbreak.**

In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Capability units IIIe–2, dryland, and IIIe–2, irrigated; Clay Loam range site.

Acuff loam, 3 to 5 percent slopes (AcC).—This gently sloping soil is in crescent-shaped bands on the northwestern and eastern sides of playas and in oblong bands along sides of draws. Areas are 10 to 100 acres in size.

The surface layer is brown loam about 10 inches thick. Below this is brown sandy clay loam about 9 inches thick. The next layer is reddish-yellow and yellowish-red sandy clay loam about 21 inches thick. Below this is pink sandy clay loam about 39 inches thick. The next layer is yellowish-red sandy clay loam.

Included with this soil in mapping are a few spots of Estacado soils and areas of Olton soils that make up 3 to 5 percent of most mapped areas.

This Acuff soil is mostly in native grasses. The hazard of soil blowing is moderate, and the hazard of erosion is severe. In the few areas that are cultivated, about half of the surface layer has been removed by erosion.

Using crop residue and level borders, terracing, and farming on the contour help to control erosion. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IVe–1, dryland, and IIIe–5, irrigated; Clay Loam range site.

Amarillo Series

The Amarillo series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils on smooth upland plains. These soils formed in old eolian deposits.

In a representative profile the surface layer is reddish-brown fine sandy loam about 9 inches thick. Below this is yellowish-red sandy clay loam about 35 inches thick. The next layer is about 12 inches of pink sandy clay loam that is about 60 percent calcium carbonate. Below this to a depth of about 102 inches is reddish-yellow sandy clay loam.

Amarillo soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is slow to medium.

These soils are well suited to native grass or to row crops. They can be used for many kinds of irrigated truck crops. Cotton, corn, grain sorghum, wheat, soybeans, castor beans, and alfalfa are the main crops.

Representative profile of Amarillo fine sandy loam, 0 to 1 percent slopes, 0.5 mile east of Farwell on south side of U.S. Highways 70 and 84; 2,550 feet west and 1,850 feet south of the northeast corner of sec. 32, T. 9 S., R. 1 E.:

A1—0 to 9 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, very coarse, prismatic structure parting to weak, subangular blocky and granular; slightly hard, very friable, slightly plastic; many fine roots; many fine and very fine pores and few medium pores; common worm casts; neutral; gradual, smooth boundary.

B21t—9 to 17 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, very coarse, prismatic structure parting to weak, subangular blocky and granular; very hard, friable, slightly sticky and plastic; many fine roots; many fine and very fine pores and few medium pores; many patchy clay films on faces of prisms; common worm casts; mildly alkaline; gradual, smooth boundary.

B22t—17 to 25 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, very coarse, prismatic structure parting to moderate, medium, subangular blocky and granular; very hard, friable, slightly sticky and plastic; many fine roots; many fine and very fine pores and few medium pores; many patchy clay films on faces of prisms; common worm casts; mildly alkaline; gradual, wavy boundary.

B23t—25 to 44 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, very coarse, prismatic structure parting to weak, coarse, subangular blocky; slightly hard, very friable; many fine roots; many fine and very fine pores and few medium pores; many patchy clay films on faces of prisms; few worm casts; many threads and films of calcium carbonate; few very fine concretions of calcium carbonate; 8 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, wavy boundary.

B24tca—44 to 56 inches, pink (5YR 7/4) sandy clay loam, light reddish brown (5YR 6/4) moist; weak, fine, subangular blocky structure intermixed with 60 percent soft masses and caliche gravel; gravel nodules ½ centimeter to 2 centimeters in diameter; few fine roots; soil part of mass is porous; clay films on faces of peds are masked by carbonates; 60 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, wavy boundary.

B25t—56 to 102 inches, reddish-yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; 80 percent soil and 20 percent pockets of caliche to a depth of 80 inches; mainly soil below a depth of 80 inches; weak, coarse, subangular blocky structure; very hard, friable; few fine roots; porous, mostly fine pores; few patchy clay films on faces of peds, especially in lower part; 10 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum is more than 80 inches thick. Secondary carbonates are at a depth of 21 to 36 inches. The zone of maximum calcium carbonate accumulation is at a depth of 30 to 60 inches. The A horizon is 7 to 12 inches thick and is reddish brown or brown. The B21t horizon is 5 to 13 inches thick and is reddish brown, yellowish red, or brown. The B22t horizon is yellowish red or reddish brown. The B21t and B22t horizons are 14 to 35 inches thick. The B22t horizon is mostly sandy clay loam, but it ranges to clay loam. The B23t horizon is mostly sandy clay loam, but it is fine sandy loam in a few places. It is 4 to 23 inches thick and is yellowish red or reddish brown. The B24tca horizon is pink, white, reddish yellow, or light reddish brown. It is 40 to 60 percent, by volume, calcium carbonate. The B25t horizon is at a depth of 50 to 110 inches. It is reddish yellow or yellowish red. Calcium carbonates in this horizon range from thin soft coatings and threads to vertical stringers that have cemented concretions.

Amarillo fine sandy loam, 0 to 1 percent slopes (AmA).—This nearly level soil is on broad, smooth plains. Most areas are 15 acres to several thousand acres in size. This soil has the profile described as representative of the Amarillo series.

Included with this soil in mapping are small round spots of Posey soils that are less than 100 feet across. Also included are areas of Acuff soils, mostly in slightly concave areas. Each of these included soils makes up about 5 percent of the mapped area. Small areas of Arvana and Olton soils are also included.

This Acuff soil is used mostly for crops. Most areas are irrigated. Small areas are used as range. The hazard of soil blowing is moderate, and the hazard of erosion is slight. A few spots have been moderately

damaged by soil blowing. In most cultivated areas, the finer particles in the plow layer have been scattered by the wind, which makes the surface layer in these areas somewhat sandier than the surface layer in grassed areas.

Irrigation systems are needed that do not increase the hazard of erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in some places. Leaving crop residue on the surface helps to control soil blowing. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, fertilizer and high-residue crops help to maintain good tilth (fig. 6). Capability units IIIe–3, dryland, and IIe–2, irrigated; Sandy Loam range site.

Amarillo fine sandy loam, 1 to 3 percent slopes (AmB).—This gently sloping soil is in elongated, oval areas 15 to 320 acres in size.

The surface layer is brown loam about 11 inches thick. The next layer to a depth of about 36 inches is yellowish-red sandy clay loam that is calcareous below a depth of 28 inches. Below this to a depth of about 69 inches is pink sandy clay loam that is about 45 percent calcium carbonate. The next layer is reddish-yellow, calcareous sandy clay loam.

Included with this soil in mapping are small spots of Posey soils and areas of Acuff soils that are a few acres in size. Also included are a few areas of a soil that has a surface layer of loam or loamy fine sand and small areas of soils that have been eroded so that the original surface layer has been removed.

This Amarillo soil is well suited to dryland crops. Many areas are irrigated. Small areas are in native range. The hazards of soil blowing and erosion are moderate.

In dryfarmed areas, terracing and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control soil blowing and erosion and to conserve moisture. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Capability units IIIe–3, dryland, and IIIe–3, irrigated; Sandy Loam range site.

Amarillo fine sandy loam, 3 to 5 percent slopes (AmC).—This gently sloping soil is in crescent-shaped bands on the northwestern slopes bordering playas and in oblong bands along sides of draws. Most areas are 10 to 35 acres in size.

The surface layer is reddish-brown fine sandy loam about 9 inches thick. The next layer is reddish-brown

***Figure 6.*—Harvesting upland cotton on irrigated Amarillo fine sandy loam, 0 to 1 percent slopes. This crop followed fertilized grain sorghum in the cropping system.**

and yellowish-red sandy clay loam about 25 inches thick. Below this is pink sandy clay loam about 15 inches thick. The next layer is light reddish-brown sandy clay loam about 14 inches thick. Below this is reddish-yellow sandy clay loam.

Included with this soil in mapping are a few spots of Posey soils, mostly less than 100 feet across, and a few areas of Olton soils that make up 3 to 5 percent of most mapped areas. Also included are areas, mostly less than 1 to 2 acres in size, that have been eroded so that the original surface layer has been removed and gullies have cut into the sandy clay loam areas below. A few areas that have about half the top layer are also included.

This Amarillo soil is mostly cultivated. Small areas are in native range. The hazard of soil blowing is moderate, and the hazard of erosion is severe.

Using level borders, terracing, and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control erosion. In irrigated areas, proper fertilization, including the addition of nitrogen and phosphate, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IVe-3, dryland, and IVe-1, irrigated; Sandy Loam range site.

Arvana Series

The Arvana series consists of nearly level, noncalcareous, loamy soils that are moderately deep to caliche. These soils formed in old eolian material on smooth plains.

In a representative profile the surface layer is reddish-brown fine sandy loam about 7 inches thick (fig. 7). Below this is about 16 inches of reddish-brown sandy clay loam. The next layer is about 3 inches of pink sandy clay loam that is about 60 percent calcium carbonate. Below this is about 6 inches of pinkish-white indurated caliche over about 43 inches of pinkish-white soft caliche that has a sandy clay loam texture and is about 70 percent calcium carbonate. The next layer to a depth of 90 inches is reddish-yellow sandy clay loam.

Arvana soils are well drained. Permeability is moderate, and available water capacity is low. Runoff is slow to medium.

These soils are well suited to native grass or to row crops. Cotton, grain sorghum, and wheat are the main crops. The soils are too droughty for dryland farming. In irrigated areas, water has to be applied frequently to be useful to crops.

Representative profile of Arvana fine sandy loam, 0 to 1 percent slopes, 5 miles east of Farwell on a county road, 2 miles south on another county road, and 0.25 mile west on turnrow on the south side of the turnrow; 300 feet south and 1,300 feet west of the northeast corner of sec. 12, T. 16 S. R. 1 E.:

Ap—0 to 7 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; massive; slightly hard, very friable; few fine roots; many very fine, fine, and medium pores; few worm casts; mildly alkaline; abrupt, smooth boundary.

B21t—7 to 14 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; very hard, friable, slightly sticky and plastic; few fine roots; many fine pores; few worm casts; common, thin, patchy clay films on faces of prisms; mildly alkaline; gradual, smooth boundary.

B22t—14 to 23 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; very hard, friable, slightly sticky and plastic; few fine roots; many fine pores; few worm casts; common, thin, patchy clay films on faces of prisms; few fine threads and films and few fine concretions of calcium carbonate; calcareous; moderately alkaline; clear, wavy boundary.

B23tca—23 to 26 inches, pink (5YR 7/4) sandy clay loam, yellowish red (5YR 5/6) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; very hard, friable, slightly sticky and plastic; few fine roots; many fine pores; few worm casts; common, thin patchy clay films on faces of peds are masked by calcium carbonate; many fine threads and films, many soft masses, and few fine concretions of calcium carbonate; 60 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, wavy boundary.

B24cam—26 to 32 inches, pinkish-white (5YR 8/2) indurated caliche, pink (5YR 7/3) moist; indurated caliche about half laminar; lamenae relatively smooth on upper surfaces with pendants about ¼ inch long on lower sides; 80 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, wavy boundary.

B25ca—32 to 75 inches, pinkish-white (5YR 8/2) soft

Figure 7.—**Profile of Arvana fine sandy loam showing indurated caliche between a depth of 2 and 3 feet.**

caliche (sandy clay loam), pink (5YR 7/3) moist; weak, coarse, subangular blocky structure; very hard, friable, slightly sticky and plastic; 70 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, wavy boundary.

B26tca—75 to 90 inches, reddish-yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; weak, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; few patches of clay films on faces of peds; many, very fine to medium, soft masses and concretions of calcium carbonate; 55 percent calcium carbonate, by volume; calcareous; moderately alkaline.

Secondary carbonates are at a depth of 14 to 28 inches. The A horizon is 7 to 12 inches thick and is reddish brown or brown. It is less than 1 percent organic matter. The B21t horizon is 6 to 8 inches thick and is reddish brown or yellowish red. The B21t and B22t horizons are 18 to 30 percent clay. They are sandy clay loam in most places but range to fine sandy loam. The B22t horizon is reddish brown or yellowish red. The B23tca horizon is pink, yellowish red, or pinkish white, but in some profiles it is not above the B24cam horizon. The B24cam horizon is at a depth of 20 to 36 inches. It is 2 to 9 inches thick and is pink or pinkish white. It is 60 to 70 percent, by volume, calcium carbonate. The hardness of this horizon ranges from 3 to 5 on the Mohs scale in at least the upper ½ inch. In most places the B25ca horizon has nearly equal calcium carbonate content and is the same color as the B23tca horizon. The B26tca horizon is at a depth of 50 to 75 inches. It is reddish yellow or pink and has calcium carbonates that range from thin soft coatings and threads to vertical stringers that have cemented concretions.

Arvana fine sandy loam, 0 to 1 percent slopes (ArA).—This nearly level soil is on broad, smooth plains. Areas are mostly irregular in shape, but some are oval. Areas range from 20 acres to several hundred acres in size, but they average about 180 acres.

Included with this soil in mapping are areas of Posey fine sandy loam, mostly less than 100 feet across. Small areas of Acuff, Amarillo, Friona, and Olton soils are also included.

This Arvana soil is used mostly for irrigated crops. A few areas are in native range. The hazard of soil blowing is moderate, and the hazard of erosion is slight. In most cultivated areas, the silt and clay in the plow layer have been scattered by the wind, which makes the surface layer in these areas somewhat sandier than the surface layer in grassed areas. Some material from the sandy clay loam lower layers has been mixed with that in the plow layer in places where plowing has been deep.

Leaving crop residue on the surface helps to control erosion and conserve moisture. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. In irrigated areas, fertilizer is needed to maintain tilth and crop production. A well-designed irrigation system is needed to control erosion (fig. 8). Capability units IIIe-3, dryland, and IIe-2, irrigated; Sandy Loam range site.

Berda Series

The Berda series consists of deep, gently sloping to sloping, calcareous, loamy soils. These soils formed in calcareous, loamy material mostly on foot slopes.

In a representative profile the surface layer is brown, calcareous loam about 6 inches thick (fig. 9). The next

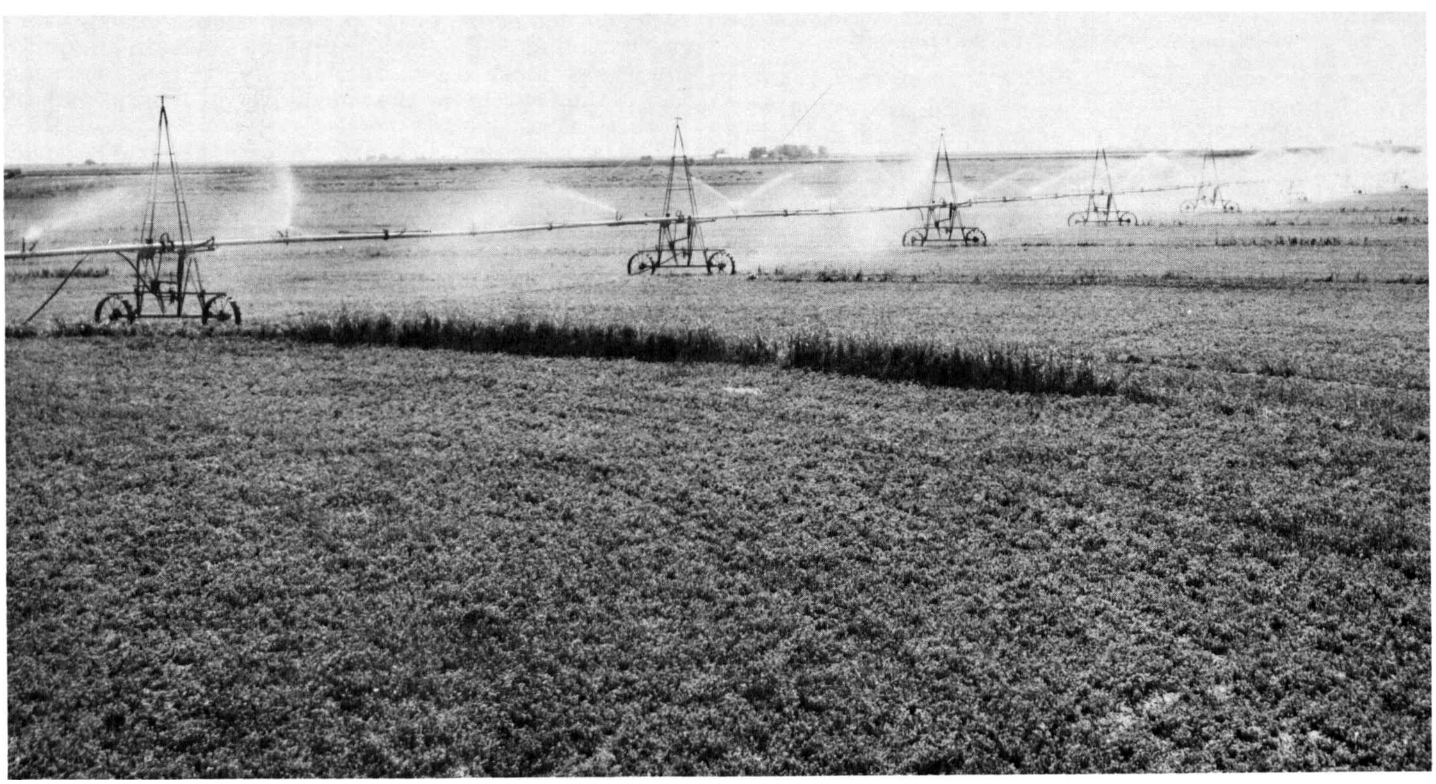

Figure 8.—Sprinkler irrigation of alfalfa on Arvana fine sandy loam.

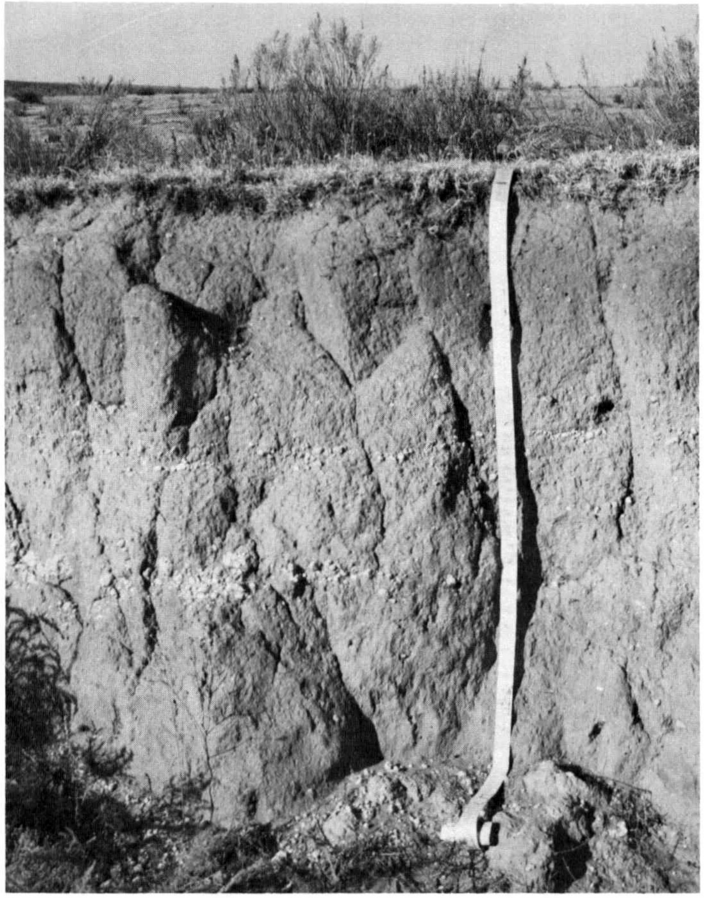

Figure 9.—Profile of Berda loam.

layer is about 21 inches of brown and light-brown, calcareous loam. The next layer is light reddish-brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 80 inches is reddish-brown and pink fine sandy loam.

Berda soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is medium. Organic-matter content is low.

These soils are used mostly as range. They are not well suited to cultivation. Grain and forage sorghums are the main crops.

Representative profile of Berda loam, 5 to 8 percent slopes, 4 miles east of Lazbuddie on Farm Road 145, 1.5 miles north on field turnrow, and 0.5 mile east in range; 2,300 feet east and 2,450 feet south of the northwest corner of sec. 62, blk. H.:

A1—0 to 6 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak, coarse, subangular blocky structure and common, single grained; slightly hard, very friable, slightly plastic; many fine roots; many fine and very fine pores and few medium pores; few worm casts; few, fine, rounded concretions of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

B21—6 to 18 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 3/4) moist; weak, very coarse, prismatic structure parting to weak, fine, subangular blocky and granular; slightly hard, very friable, slightly plastic; common fine roots; many fine and very fine pores and few medium pores; many worm casts; few, very fine to fine, rounded but etched concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B22—18 to 27 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 4/4) moist; weak, very coarse, prismatic structure parting to weak, fine, subangular blocky and granular; slightly hard, very friable, slightly plastic; common fine roots; very fine and fine pores and few medium pores; common worm casts; few very fine, fine, and medium, rounded but etched concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B23ca—27 to 36 inches, light reddish-brown (5YR 6/4) loam, reddish brown (5YR 5/4) moist; weak, coarse, subangular blocky and granular structure; slightly hard, very friable, slightly plastic; few fine roots; common worm casts; few, very fine, fine, and medium, rounded but etched concretions of calcium carbonate; few faint films of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C1—36 to 63 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, massive and single grained; slightly hard, very friable, slightly plastic; few fine roots; many fine and very fine pores and few medium pores; few, very fine to medium, rounded but etched concretions of calcium carbonate; calcareous; moderately alkaline; diffused, smooth boundary.

C2—63 to 80 inches, pink (5YR 7/4) fine sandy loam, light reddish brown (5YR 6/4) moist; weak, massive and single grained; slightly hard, very friable, slightly plastic; few fine roots; many fine and very fine pores and few medium pores; few, medium, rounded concretions of calcium carbonate; calcareous; moderately alkaline.

The A horizon is 6 to 14 inches thick. It is brown, grayish brown, dark grayish brown, and reddish brown. The B21, B22, and B23ca horizons are light yellowish brown, brown, light brown, yellowish brown, or light reddish brown. The C horizon is light reddish-brown, light-brown, pink, or reddish-brown loam or fine sandy loam.

Berda loam, 3 to 5 percent slopes (BeC).—This gently sloping soil is mostly on foot slopes in long, narrow areas. Most areas are about 400 to 800 feet wide, follow the contour of the side slopes of draws, and are 15 to 70 acres in size.

The surface layer is brown loam about 11 inches thick. The next layer is brown loam about 15 inches thick. Below this is about 12 inches of yellowish-brown clay loam. The underlying material to a depth of 84 inches is light-brown clay loam.

Included with this soil in mapping are small areas of Bippus soils on lower parts of slopes and Estacado soils on upper parts of slopes. Also included are a few small areas of Acuff, Olton, and Potter soils and areas of soils that are fine sandy loam.

This Berda soil is used mostly as range. Some areas are cultivated. The hazards of soil blowing and erosion are moderate.

Terraces, contour farming, diversion terraces, and grassed waterways are needed to carry off excess water. This soil is easy to work. In irrigated areas, alfalfa, perennial grasses, and other soil-improving crops are needed to maintain tilth. A sprinkler system of irrigation is best suited to this soil. Growing residue-producing and protective crops continuously, using fertilizers, limiting tillage, and leaving residue on the surface help to reduce soil blowing and erosion. Rough surface tillage helps to control soil blowing when residue is inadequate. Capability units IVe-3, dryland, and IVe-2, irrigated; Hardland Slopes range site.

Berda loam, 5 to 8 percent slopes (BeD).—This slop-

ing soil is on foot slopes along draws. Areas are 20 to 800 acres in size. Slopes range from 5 to 8 percent, but they are mainly about 6 percent. This soil has the profile described as representative of the Berda series.

Included with this soil in mapping are spots of Potter soils that make up as much as 5 percent of the smaller mapped areas, areas of Posey soils that surround the Potter soils, and areas of Acuff loam. Areas of Berda loam, 3 to 5 percent slopes, that are on lower slopes are also included.

This Berda soil is used mostly as range (fig. 10). This soil is not suited to cultivation. The hazard of soil blowing is moderate, and the hazard of erosion is severe. Capability unit VIe-2, dryland; Hardland Slopes range site.

Bippus Series

The Bippus series consists of deep, friable, nearly level to gently sloping, noncalcareous, loamy soils. These soils formed in loamy outwash material along alluvial fans and valley fills.

In a representative profile the surface layer is brown, very dark grayish-brown, and dark grayish-brown clay loam about 19 inches thick. The next layer to a depth of 66 inches is brown clay loam.

Bippus soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is medium.

These soils are well suited to native grass or to row crops. Most areas are used as range, but a few areas are used for crops. Grain and forage sorghums are the main crops. These soils have potential for use as irrigated pasture.

Representative profile of Bippus clay loam, 0 to 1 percent slopes, 2 miles east of Hub on Texas Highway 86, 3.8 miles south on a county road, on the east side of the road, in range; 200 feet east and 30 feet south of the northwest corner of sec. 7, Kelly subdivision:

A11—0 to 2 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak, medium to thick, platy structure (due to cattle tramping and accumulation of layers); slightly hard, friable, slightly sticky and plastic; common fine roots; mildly alkaline; abrupt, smooth boundary.

A12—2 to 9 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; weak, coarse, subangular blocky and granular structure; hard, friable, slightly sticky and plastic; common fine roots; many fine, medium, and coarse

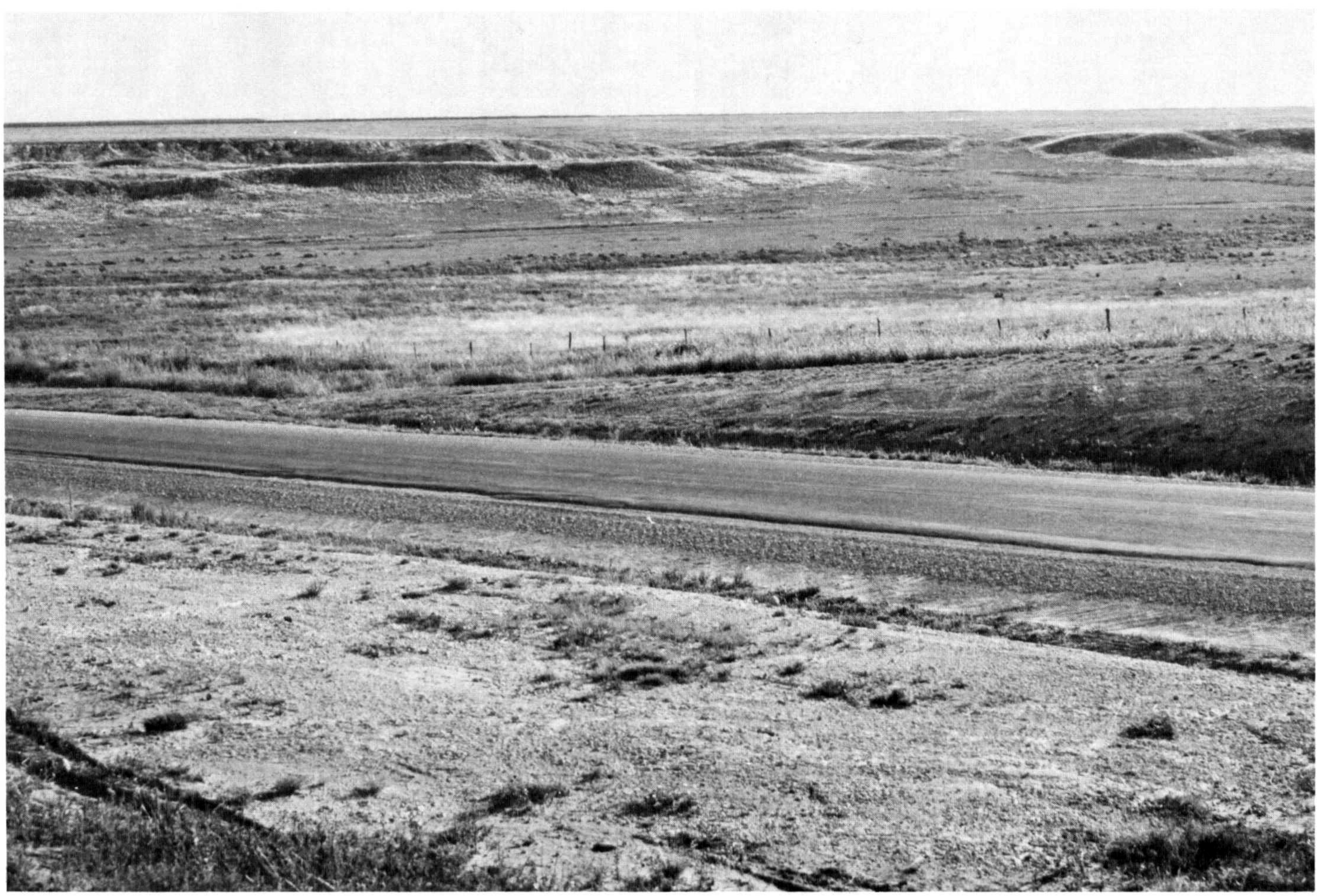

Figure 10.—**Berda loam, 5 to 8 percent slopes, in range along Running Water Draw. Berda soils are below the knobs of Potter soils on far side of draw.**

pores; few worm casts; mildly alkaline; clear, smooth boundary.

A13—9 to 19 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic and subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many worm casts; mildly alkaline; clear, smooth boundary.

B2—19 to 36 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate to weak, subangular blocky structure; hard, friable, slightly sticky and plastic; porous; threads and fine concretions of calcium carbonate; 8 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B2ca—36 to 66 inches, brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate to weak, subangular blocky and porous structure; hard, friable, slightly sticky and plastic; porous; many threads and few fine concretions of calcium carbonate; 9 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum is more than 50 inches thick. A few inches of brown, grayish-brown, dark reddish-gray, or reddish-brown loamy material has been deposited on the surface in some places. The A horizon ranges from 12 to 35 inches in thickness and averages about 23 inches thick. The A horizon is mostly dark grayish brown, but it ranges to brown, dark brown, very dark grayish brown, dark grayish brown, or grayish brown. It is clay loam or fine sandy loam. The B2 and B2ca horizons are brown, grayish brown, dark grayish brown, reddish brown, light reddish brown, light brown, pale brown, light yellowish brown, yellowish brown, or reddish yellow. They are fine sandy loam, clay loam, or sandy clay loam. Calcium carbonates in the Bca horizon are mostly films, threads, a few soft powdery masses, and a few fine concretions.

Bippus fine sandy loam, 0 to 1 percent slopes (BfA).—This nearly level soil is made up of old flood plain deposits. Slopes are mostly less than 0.4 percent. Areas are smooth. They range from a few hundred feet to more than 1,000 feet wide and are about 1/8 mile to several miles in length along some draws. They average about 60 acres in size but range from 25 acres to several hundred acres.

The surface layer is dark grayish-brown, calcareous fine sandy loam about 5 inches thick. The next layer is brown fine sandy loam about 5 inches thick. Below this is about 20 inches of brown sandy clay loam. The next layer is brown clay loam about 10 inches thick. Below this is about 14 inches of brown fine sandy loam. The next layer to a depth of 80 inches is brown sandy clay loam.

Included with this soil in mapping are a few small areas of a soil that is similar to this Bippus soil but is noncalcareous to a depth of 48 inches. Also included are a few areas of soils that have slopes of 2 percent.

This Bippus soil is used mostly as range. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Leaving crop residue on the surface helps to control soil blowing. Rough surface tillage helps to control soil blowing when residue is inadequate. In irrigated areas, using fertilizer helps to maintain tilth and improve crop production. A well-designed irrigation system helps to assure proper application of water and to control soil and water losses. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Capability units IIIe–3, dryland, and IIe–2, irrigated; Valley range site.

Bippus clay loam, 0 to 1 percent slopes (BpA).—This nearly level soil is on old flood plains and bottom lands along draws and their tributaries. Areas are 200 feet to more than 2,000 feet wide and are as much as several miles in length along draws. This soil has the profile described as representative of the Bippus series.

Included with this soil in mapping are small spots of Pullman, Randall, and Spur soils. Also included are areas of soils that have a sandy clay loam surface layer and some small spots of soils that have an overwash of fine sandy loam or loam.

This Bippus soil is suited to dryfarmed or irrigated crops, but only a few areas are irrigated. Most areas are not cultivated, because areas of this soil are small and areas of adjoining soils, such as Berda and Posey soils, are sloping and are not suitable for cultivated crops. The hazards of soil blowing and erosion are slight.

In dryfarmed areas, leaving crop residue on the surface helps to control soil blowing and erosion and to conserve moisture. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Timely but limited tillage, diversion terraces, and grassed waterways help to control erosion. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Capability units IIe–1, dryland, and IIe–1, irrigated; Valley range site.

Bippus clay loam, 1 to 3 percent slopes (BpB).—This gently sloping soil is on valley fills and on fans along draws. A few areas are along some short draws that drain into larger playas of the county. The surface is smooth, and in most places, it is slightly concave. Slopes average about 1.5 percent, but they range from 0.7 to 3 percent. Areas range from 5 to 30 acres in size, but they average about 15 acres.

The surface layer is dark grayish-brown clay loam about 27 inches thick. Below this to a depth of about 55 inches is brown, calcareous clay loam that has calcium carbonates in the lower part. The next layer to a depth of about 80 inches is brown, calcareous sandy clay loam that is enriched with carbonates in the upper part.

Included with this soil in mapping are areas of Estacado soils and areas of soils that have a surface layer only 12 inches thick. Also included are some areas of soils that have a surface layer of sandy clay loam, fine sandy loam, or loam.

This Bippus soil is used mostly as range. A few areas are cultivated. The hazard of soil blowing is slight, and the hazard of erosion is moderate.

In dryfarmed areas, using terraces and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control soil blowing and erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–2, dryland, and IIIe–2, irrigated; Valley range site.

Bippus and Spur soils, frequently flooded (Bs).—This mapping unit is made up of about 55 percent Bippus soils, 35 percent Spur soils, and 10 percent scoured stream channels and areas on toe slopes that mainly

consist of Berda soils. These nearly level soils consist of old flood plain deposits in draws along intermittent streams. Some areas are entirely Bippus soils, some are Spur soils, and some contain both soils. The areas form a nearly continuous strip that is mainly 200 to 400 feet wide but ranges from 600 to 800 feet in a few places. Slopes are 0 to 1 percent. Relief is uneven.

The Bippus soils have a surface layer of dark grayish-brown clay loam about 12 inches thick. Below this is brown clay loam about 23 inches thick. The next layer is yellowish-brown sandy clay loam about 10 inches thick. Below this to a depth of 69 inches is brown clay loam.

The Spur soils are in channels. They have the profile described as representative of the Spur series.

Included with these soils in mapping are a few depressions of dark-gray clay in channels and in a few other places.

The hazards of soil blowing and erosion are slight. These soils are flooded at least once every 4 to 10 years.

This mapping unit is not suited to cultivation. Almost all areas are used as range. In some areas of Spur soils, the plant cover is thick, but in other areas there is no plant cover. All areas of Bippus soils are thickly vegetated. Capability unit Vw–1, dryland; Valley range site.

Estacado Series

The Estacado series consists of deep, nearly level to gently sloping, calcareous, loamy soils on smooth uplands. These soils formed in eolian material.

In a representative profile the surface layer is dark grayish-brown and brown, calcareous clay loam about 13 inches thick (fig. 11). The next layer is brown and light-brown clay loam about 15 inches thick. Below this to a depth of 90 inches is pink, light-brown, and reddish-yellow clay loam.

Estacado soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is slight.

These soils are well suited to native grass or to row crops. Cotton, corn, grain sorghum, wheat, and soybeans are the main crops.

Representative profile of Estacado clay loam, 1 to 3 percent slopes, 3.5 miles northeast of Friona on U.S. Highway 60, 0.5 mile north on a county road, on the east side of the road; 1,400 feet south and 100 feet east of the northwest corner of sec. 26, T. 1 N., R. 4 E.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine and fine pores and few medium pores; few worm casts; few very fine concretions of calcium carbonate; 9 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—8 to 13 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, subangular blocky and granular structure; hard, friable, slightly sticky and plastic; common fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few very fine concretions and few threads and films of calcium carbonate; 13 percent calcium carbonate, by volume; calcareous; moderately alkaline; clear, smooth boundary.

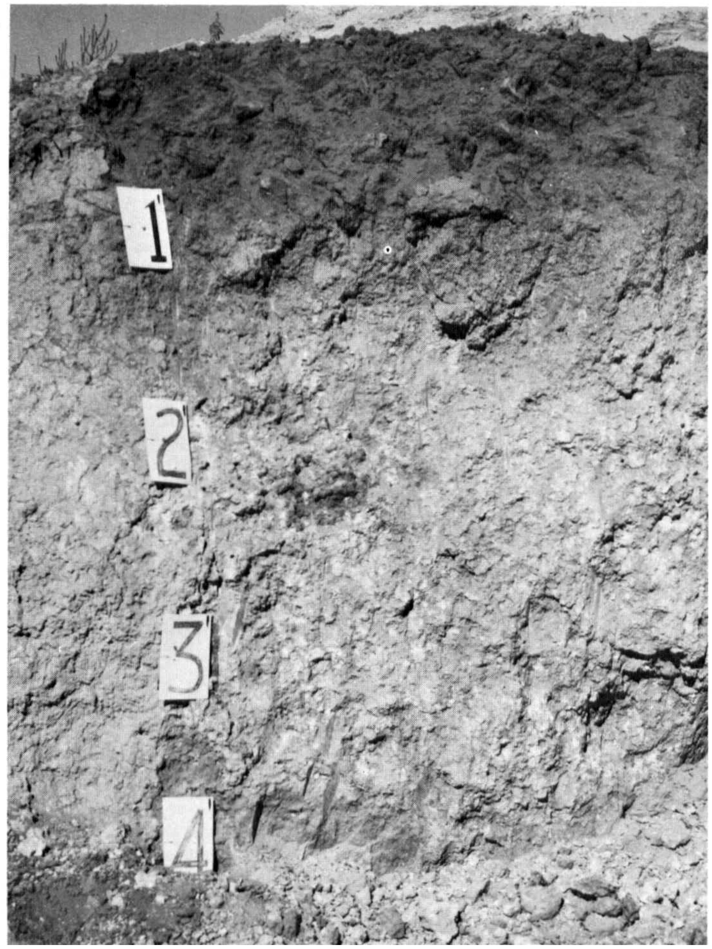

Figure 11.—**Profile of Estacado clay loam showing carbonates, which occur as soft masses and concretions below the surface layer.**

B21tca—13 to 19 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 4/2) moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; hard, friable, slightly sticky and plastic; common fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few patchy clay films on faces of prisms; few very fine concretions and few threads and films of calcium carbonate; 21 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B22tca—19 to 28 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 4/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable, slightly sticky and plastic; common fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few patches of clay films on faces of prisms; few very fine concretions of calcium carbonate; few threads and many faint patches of calcium carbonate; 21 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B23tca—28 to 43 inches, pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular; slightly hard, friable, slightly sticky, plastic; few fine roots; many very fine pores, common fine pores, and few medium pores; few worm casts in upper part; few patchy clay films on faces of prisms;

many, medium and coarse, soft masses and common medium and few fine concretions of calcium carbonate; 35 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, wavy boundary.

B24tca—43 to 59 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine pores, common fine pores, and few medium pores; few patches of clay films on some faces of prisms; many, medium, soft masses and concretions of calcium carbonate; 42 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffused, wavy boundary.

B25tca—59 to 75 inches, light-brown (7.5YR 6/4) clay loam, strong brown (7.5YR 5/6) moist; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine pores, common fine pores, and few medium pores; few clay films on faces of peds, mostly masked by carbonates; many, medium, soft masses and concretions of calcium carbonate; 54 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffused, wavy boundary.

B26tca—75 to 90 inches, reddish-yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; moderate to weak, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine pores, common fine pores, and few medium pores; few patches of clay films on faces of peds; common, medium and fine, soft masses and concretions and few threads of calcium carbonate; calcareous; moderately alkaline.

The solum is more than 60 inches thick. The zone of maximum calcium carbonate accumulation is at a depth of 15 to 30 inches. The A horizon is 7 to 17 inches thick and is dark brown, brown, grayish brown, or dark grayish brown. The B21tca and B22tca horizons are 15 to 42 inches thick and are brown, light yellowish brown, yellowish brown, grayish brown, reddish brown, light reddish brown, light brown, and strong brown. They are mostly clay loam but range to sandy clay loam. Visible calcium carbonates mostly make up 10 to 20 percent of the B21tca horizon, 20 to 65 percent of the B22tca, B23tca, B24tca, and B25tca horizons, and then the percentage decreases with depth. Local pockets in which the content of calcium carbonate is as much as 80 percent are in many places. The B23tca, B24tca, and B25tca horizons are 20 to 45 inches thick and are very pale brown, white, light yellowish brown, light brown, pink, or pinkish white. The B26tca horizon is reddish yellow, yellowish red, or red. It is mostly clay loam but ranges to sandy clay loam.

Estacado clay loam, 0 to 1 percent slopes (EsA).—This nearly level soil is on smooth plains. Areas range from 5 to 900 acres in size, but they average about 40 acres. The areas are irregular and oval or elongated in shape. Slopes are mainly 0.3 to 0.7 percent.

The surface layer is brown, calcareous clay loam about 15 inches thick. Below this is reddish-brown, calcareous clay loam about 17 inches thick. The next layer is about 38 inches of pinkish-white, calcareous clay loam that is 65 percent calcium carbonate. Below this to a depth of about 80 inches is light yellowish-brown, calcareous clay loam.

Included with this soil in mapping are areas of soils, mostly less than 5 acres in size, that are 40 percent or more calcium carbonates at a depth of 10 to 20 inches. Small areas of Posey soils are also included. These soils make up less than 10 percent of the mapped areas. Also included are areas of soils that are noncalcareous to a depth of 6 inches or less and areas of soils that are noncalcareous to a depth of 9 inches. Each of these soils makes up 10 percent of the mapped area. Some areas of soils that have a surface layer of loam are included, mostly in association with other loam soils.

About two-thirds of this Estacado soil is cultivated. The rest is used as range. Most cultivated areas are irrigated. The hazard of soil blowing is severe, and the hazard of erosion is slight.

Farming on the contour, terracing, and using diversion terraces and grassed waterways help to control erosion. Leaving residue from such crops as small grain and sorghums on the surface helps to control soil blowing and erosion (fig. 12). Using fertilizer helps to maintain soil tilth. A well-designed irrigation system helps to control soil and water losses. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–6, dryland, and IIe–1, irrigated; Hardland Slopes range site.

Estacado clay loam, 1 to 3 percent slopes (EsB).—This gently sloping soil is in slightly convex, oblong bands on side slopes of playa basins. It is along draws in some places. Areas range from 5 to 350 acres in size, but they are mostly about 45 acres. Slopes average about 2 percent. This soil has the profile described as representative of the Estacado series.

Included with this soil in mapping are areas of Acuff, Olton, and Posey soils. Also included are several small eroded areas and areas of soils that are noncalcareous in the upper few inches. Areas of loamy soils are included in some of the large areas of Acuff soils.

This Estacado soil is mostly cultivated, but a few areas are in range. Most cultivated areas are irrigated. The hazard of soil blowing is severe, and the hazard of erosion is moderate. Terracing and farming on the contour help to control runoff. Diversion terraces and grassed waterways are needed to carry off excess water. Leaving crop residue on the surface helps to control soil blowing. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, using fertilizer helps to maintain soil tilth. A well-designed irrigation system helps to control soil and water losses. Bench leveling or graded borders help to control erosion and to conserve moisture. Capability units IIIe–2, dryland, and IIIe–2, irrigated; Hardland Slopes range site.

Estacado-Posey complex, 3 to 5 percent slopes (EtC).—This complex is 50 percent Estacado soil, 40 percent Posey soil, and 10 percent other soils. These gently sloping soils are in long areas, 400 to 800 feet wide, around playas and along draws. Areas range from 5 to 100 acres in size, but they average about 30 acres around playas and 40 acres along draws.

The Estacado soil is below the Posey soil in areas where slopes are less convex to slightly concave. Also, the Estacado soil is above and below the Posey soil in areas where slopes are short. It has a surface layer of brown clay loam about 15 inches thick. Below this is brown clay loam about 19 inches thick. The next layer to a depth of 57 inches is reddish-brown clay loam that is high in content of calcium carbonate. Below this to a depth of 85 inches is reddish-yellow clay loam.

The Posey soil is in convex areas on the upper part of long slopes and the middle part of short slopes. It has a surface layer of brown loam about 9 inches thick. The next layer is about 54 inches of reddish-brown and reddish-yellow clay loam that is high in content of cal-

Figure 12.—**Grain sorghum stubble on Estacado clay loam. The stubble was left standing to help prevent soil blowing and to conserve moisture.**

cium carbonate. Below this is yellowish-red clay loam that extends to a depth of 80 inches.

Included with these soils in mapping are areas of Acuff, Bippus, and Olton soils.

The soils in this complex are used mostly as range. A few small areas are used for irrigated pasture (fig. 13). Some small areas are cultivated with large areas of other soils. The hazards of soil blowing and erosion are moderate.

Leaving crop residue on the surface helps to control soil blowing and erosion. Using diversion terraces and grassed waterways, farming on the contour, and terracing help to control erosion. Rough surface tillage helps to control soil blowing when crop residue is inadequate. A well-designed irrigation system helps to control soil and water losses. In pastures, grazing management, fertilizer, frequent irrigation, and rotation grazing are essential. Capability units IVe–4, dryland, and IVe–2, irrigated; Hardland Slopes range site.

Friona Series

The Friona series consists of nearly level, noncalcareous, loamy soils that are moderately deep to caliche. These soils formed in loamy eolian material on smooth uplands.

In a representative profile the surface layer is brown loam about 8 inches thick (fig. 14). The next layer is brown and yellowish-red sandy clay loam about 23 inches thick. Below this is about 4 inches of pinkish-white, indurated and strongly cemented caliche. The next layer is pinkish-white sandy clay loam about 24 inches thick. Below this to a depth of about 84 inches is pink sandy clay loam.

Friona soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is slow to medium.

These soils are used mostly for crops. A few small areas are in native range. Cotton, grain sorghum, corn, wheat, and soybeans are the main crops.

Representative profile of Friona loam, 0 to 1 percent slopes, 3 miles west of Lazbuddie on Farm Road 145, then 3 miles south on a county road; 1,600 feet west and 1,000 feet south of the northeast corner of sec. 38, Doud and Keefer:

Ap—0 to 8 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, very friable; many fine roots; mildly alkaline; abrupt, smooth boundary.

Figure 13.—**Irrigated pasture on bench-leveled Estacado-Posey complex, 3 to 5 percent slopes. A grassed waterway is in the foreground.**

B21t—8 to 15 inches, brown (7.5YR 4/2) sandy clay loam, dark brown (7.5YR 3/2) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, friable, slightly sticky and plastic; many pores; many worm casts; thin patchy clay films, mostly on faces of prisms; mildly alkaline; clear, smooth boundary.

B22t—15 to 26 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, coarse, prismatic structure parting to weak, fine, subangular blocky; hard, friable, slight sticky and plastic; many fine pores; common worm casts; patchy clay films on faces of prisms; noncalcareous; moderately alkaline; gradual, wavy boundary.

B23t—26 to 31 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; hard, friable, slightly sticky and plastic; many fine pores; common worm casts; thin patchy clay films, mostly on faces of prisms; few threads, films, and fine masses of calcium carbonate; calcareous; moderately alkaline; abrupt, wavy boundary.

B24cam—31 to 35 inches, pinkish-white (7.5YR 8/2) caliche, indurated in upper part and strongly cemented in lower part; laminar and smooth in the upper surface; pendants of calcium carbonate as much as 1 centimeter long in the lower part; gradual, wavy boundary.

B25ca—35 to 59 inches, pinkish-white (7.5YR 8/2) sandy clay loam, pink (7.5YR 7/4) moist; weak, medium, subangular blocky structure; slightly hard, friable; about 50 percent calcium carbonate in soft powdery forms; calcareous; moderately alkaline; gradual, wavy boundary.

B26tca—59 to 84 inches, pink (5YR 7/4) sandy clay loam, reddish yellow (5YR 6/6) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common, very fine and fine pores; few, thin, patchy clay films on faces of peds; about 20 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline.

The B2cam horizon is 22 to 36 inches thick. Secondary carbonates are at a depth of 18 to 26 inches. The A horizon is 6 to 10 inches thick and is dark brown or brown. It is neutral or mildly alkaline. The B21t horizon is 4 to 9 inches thick. It is dark-brown or brown sandy clay loam or loam. The B22t and B23t horizons are reddish brown, yellowish red, reddish yellow, light brown, or brown. They are sandy clay loam, clay loam, or loam and are 25 to 35 percent clay. The B24cam horizon is 2 to 24 inches thick and is pink or pinkish white. It has a hardness of 3 to 5 on Mohs scale in at least the upper ½ inch. The B25ca horizon is pink, pinkish-white, light reddish-brown, light-brown, or reddish-yellow clay loam or sandy clay loam. It is 20 to 50 percent calcium carbonate, by volume. The B26tca and B27t horizons are red, reddish-yellow, or yellowish-red sandy clay loam to clay loam.

Friona loam, 0 to 1 percent slopes (FrA).—This nearly level soil is on broad, smooth plains that are mostly in

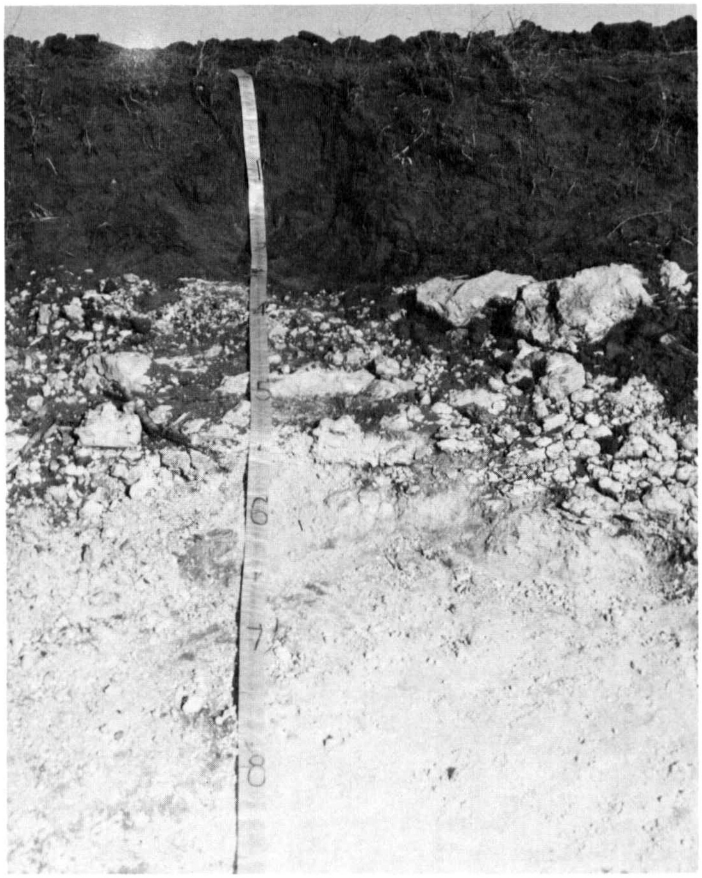

Figure 14.—**Profile of Friona loam showing the indurated and strongly cemented layer below a depth of 31 inches that stops the growth of roots.**

irregular oval areas. Most areas range from 15 to 450 acres in size, but they average about 130 acres.

Included with this soil in mapping are many spots of Estacado soils, mostly less than 100 feet across, that make up about 5 percent of each of the mapped areas. Small areas of Acuff, Amarillo, and Olton soils and a few areas of soils that have a surface layer of sandy clay loam are also included.

This soil is used mainly for irrigated crops. Some areas are dryfarmed. Small areas remain in native range. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Leaving crop residue on the surface helps to control soil blowing and erosion. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, using fertilizer helps to maintain soil fertility and crop production. A well-designed irrigation system helps to control soil and water losses. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Capability units IIIe-6, dryland, and IIe-1, irrigated; Clay Loam range site.

Kimbrough Series

The Kimbrough series consists of gently sloping, calcareous, loamy soils that are very shallow to shallow to caliche. These soils formed in calcareous loamy material on smooth uplands.

In a representative profile the surface layer is about 8 inches of dark grayish-brown, calcareous loam that has some caliche gravel, cobbles, and stones. The next layer is about 5 inches thick. It is about 80 percent pink caliche gravel, cobbles, and stones and 20 percent brown clay loam. The underlying material is indurated caliche in fractured sheets.

Kimbrough soils are well drained. Permeability is moderate, and available water capacity is very low. Runoff is slow to medium.

These soils are used as range. They are not suited to cultivation.

Representative profile of Kimbrough loam, 1 to 5 percent slopes, 6.75 miles east and 0.25 mile south of northwest corner of Parmer County or 10 miles west of Friona on Farm Road 1731, then 4.5 miles north on a county road, then 2.25 miles west on another county road and 1.25 miles north on a third county road, then about 1.5 miles northeast of the road, in range; 1,100 feet north and 1,350 feet west of the southeast corner of sec. 30, T. 2 N., R. 2 E.:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, subangular blocky structure parting to weak, fine, subangular blocky and granular; hard, friable, slightly sticky and plastic; many fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few gravel, cobble, or stone fragments of caliche; calcareous; moderately alkaline; abrupt, broken boundary.

C1cam—8 to 13 inches, pink (5YR 8/4), light reddish brown (5YR 6/4) moist; 80 percent gravel, cobble, and stone fragments of caliche; 20 percent brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; hard, friable, slightly sticky and plastic; gravel, cobbles, and flattened stones that are smooth on top and have white (N 8/) ¼ to ½ inch pendants on the bottoms; calcareous; moderately alkaline; abrupt, wavy boundary.

C2cam—13 to 60 inches, pink (5YR 8/4), light reddish brown (5YR 6/4) moist; indurated caliche in fractured sheets ½ inch to several inches thick that have white calcium carbonate coatings; exterior calcium carbonate coatings ⅛ to ¼ inch thick laminated and very strongly cemented, extremely hard; pockets of soil about same color below this surface crust that has many more plates; calcareous; moderately alkaline; indurated caliche softer in lower part.

The A horizon is brown, dark grayish brown, or dark brown and is less than 35 percent gravel. The depth to the C1cam horizon ranges from 5 to 13 inches. The C1cam horizon ranges from fractured, indurated, and thinly laminar to continuously indurated, thickly laminar. It has very little to several feet of pisolitic structure below the lamella. The hardness of this horizon is 5 or more on Mohs scale for several inches to several feet or more.

Kimbrough loam, 1 to 5 percent slopes (KmC).—This gently sloping soil is on low convex crests of broad ridges bordering playa basins and draws. Areas are oval to long and oval in shape and are 5 to 100 acres in size, but they average about 20 acres.

Included with this soil in mapping are areas of a soil that is similar to Kimbrough soil, but it has a brown surface layer. Also included are areas of a soil that is similar to Kimbrough soil, but it has a surface layer of clay loam. A few areas that have indurated caliche at a depth of 20 to 30 inches are also included. Some flags

of indurated laminated caliche are on the surface in most areas.

This Kimbrough soil is used mostly as range, but a few small areas are cultivated. This soil is not suited to cultivation. Capability unit VIIs-1, dryland; Very Shallow range site.

Likes Series

The Likes series consists of deep, gently sloping to sloping and undulating, calcareous, sandy soils on undulating dunes. These soils formed in unconsolidated sand and sandstone on uplands.

In a representative profile the surface layer is brown loamy fine sand about 9 inches thick. The underlying material to a depth of 62 inches is light-brown fine sand.

Likes soils are excessively drained. Permeability is moderately rapid, and available water capacity is low. Runoff is slow.

These soils are suited to use as range and wildlife habitat.

Representative profile of Likes loamy fine sand, 1 to 8 percent slopes, 10 miles west of Friona on Farm Road 1731, then 2 miles west on Farm Road 2013 and 0.5 mile south of the road, in range; 2,000 feet west and 500 feet north of the southeast corner of sec. 15, Rhea Brothers subdivision A:

A1—0 to 9 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) moist; weak, fine, granular structure and single grained; soft, very friable; common fine roots; many fine and medium pores; few worm casts; few very fine concretions of calcium carbonate; 2 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

C1—9 to 24 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist; single grained; loose, very friable; common fine roots; many pores; common very fine concretions of calcium carbonate; 8 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, smooth boundary.

C2—24 to 62 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist; single grained; loose, very friable; few fine roots; many pores; common very fine concretions of calcium carbonate; 10 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The A horizon is 5 to 13 inches thick and is brown or grayish brown. The C horizon is brown, pale brown, very pale brown, light brown, yellowish brown, or light yellowish brown. It is mostly fine sand or loamy fine sand, but it is fine sandy loam in some profiles below a depth of 40 inches. This horizon has a slight accumulation of calcium carbonate, but some profiles have few to common very fine concretions.

Likes loamy fine sand, 1 to 8 percent slopes (LkD).—This soil is on vegetated dunes 6 to 15 feet high. The dunes have a rather sharp crest and side slopes. Slopes on the eastern side are mostly 5 percent steeper than those on the western side. Areas are long and oval and are parallel to the intermittent stream channel. Most of the larger areas are on the northern or eastern side of the channel.

Included with this soil in mapping are eroded spots that make up 5 percent of the mapped areas. These eroded spots are made up of gullies and small blowouts less than ½ acre in size. Areas of Estacado, Mobeetie, and Potter soils are also included. In places the surface layer is fine sand or fine sandy loam, and in some places the soil is noncalcareous to a depth of about 20 inches. Some areas of soils that have loamy strata at a depth of 80 to 100 inches are also included.

This Likes soil is well suited to range, but it is not suited to cultivation. All areas are in native grass. The hazard of soil blowing is severe, and the hazard of erosion is slight. Capability unit VIe-1, dryland; Sandy range site.

Lipan Series

The Lipan series consists of deep, nearly level, calcareous, clayey soils on benches or in depressional areas on uplands. These soils formed in calcareous clayey material.

In a representative profile the surface layer is gray clay about 18 inches thick. The next layer is about 30 inches of grayish-brown clay that has wide cracks and slickensides. Below this is light brownish-gray clay about 15 inches thick. The underlying material to a depth of about 70 inches is white clay.

Lipan soils are moderately well drained. These soils crack and take in water readily when dry, but permeability is very slow when they are wet. Available water capacity is high. Runoff is slow.

These soils are well suited to native grass or to most row crops. Grain sorghum and wheat are the main crops. The soils have potential for irrigated pasture grasses or legumes. These soils are droughty if they are dryfarmed, but some crops do not do well if the soils are saturated.

Representative profile of Lipan clay, depressional, 2 miles northeast of Black on U.S. Highway 60, then about 0.63 mile north of the highway; 2,700 feet west 600 feet south of the northeast corner of sec. 2, Davis subdivision:

Ap—0 to 6 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak, coarse, subangular blocky structure parting to fine, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many fine and very fine pores; few fine calcium carbonate concretions; 23 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—6 to 18 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, coarse, blocky structure; some parallelepipeds or wedge-shaped peds ¼ to ½ inch long in bottom few inches; shiny pressure faces on slickensides and peds; many fine roots; few fine pores; few fine concretions of calcium carbonate; 21 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, wavy boundary.

AC1—18 to 48 inches, grayish-brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; weak, medium, blocky structure; parallelepipeds or wedge-shaped peds ¼ inch to ½ inch long; grooved slickensides to below a depth of 40 inches; intersecting slickensides at least 3 inches across and most strongly expressed at a depth of 20 to 40 inches; evident shiny pressure faces on peds; few fine roots penetrate peds; few, whitish, fine soft lumps of calcium carbonate; 10 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

AC2—48 to 63 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; weak to moderate, medium, blocky and subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; few fine and very fine pores; few, fine, whitish, soft lumps of calcium carbonate; few indistinct threads of calcium carbonate; 12 percent calcium

carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

Cca—63 to 70 inches, white (10YR 8/1) clay, light gray (10YR 7/2) moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few fine roots; few fine and very fine pores; few, fine, broken chips of snail shells; few to many, fine, whitish soft lumps of calcium carbonate; few calcium carbonate threads; 16 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The A horizon ranges from 15 to 20 inches in thickness and is gray or dark gray. The most distinct grooved intersecting slickensides and parallelepipeds are at a depth of 15 to 40 inches. The AC horizon is grayish brown, gray, brown, or light brownish gray. The Cca horizon is 15 percent or slightly more, by volume, calcium carbonate in the form of a few threads, soft lumps, and concretions. The C horizon ranges from clay to sandy clay, clay loam, or loamy fine sand. It is white, pale brown, or very pale brown.

Lipan clay, depressional (Lp).—This nearly level soil is on benches 3 to 10 feet above the floor of associated playas of Randall clay. Areas are irregular or crescent in shape and range from 10 acres to about 100 acres in size, but they average about 50 acres. The surface is slightly concave. Grassed areas have a slight gilgai microrelief. Depressions are 3 to 8 feet apart and are 3 to 8 inches lower than surrounding areas. Slopes are 0 to 1 percent.

Included with this soil in mapping are some areas of slightly less clayey soils that have secondary calcium carbonates at a depth of 40 inches or more. Also included are some areas of soils that have a surface layer of clay about 13 inches thick over lower layers similar to those described as representative of the Lipan series. Small areas of Estacado soils, small areas of dark-gray soils that are noncalcareous, and some areas of Lipan clay, 1 to 2 percent slopes, are also included. These soils are on the rims of playas.

About half the areas of this Lipan soil are cultivated, and about half are used as native range. The hazard of soil blowing is moderate, and the hazard of erosion is slight. This soil is flooded once in 3 to 10 years. During years in which a large amount of rain falls, areas of Lipan soil in places along playa basins are inundated for several weeks.

Leaving crop residue on the surface helps to control soil blowing and to maintain soil tilth. The surface layer is hard when it is dry, and it tends to clod if tilled. The clayey lower layers are compact and hard to plow. They are extremely hard when dry and sticky when wet. In irrigated areas, using fertilizer and leaving a large amount of crop residue on the surface help to maintain tilth and to control soil blowing. A well-designed irrigation system helps to control soil and water losses. A recovery system for runoff irrigation water is needed in most places. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Rough surface tillage helps to control soil blowing when residue is inadequate. Capability units IVw–1, dryland, and IVs–1, irrigated; Lakebed range site.

Mobeetie Series

The Mobeetie series consists of deep, nearly level to gently undulating, noncalcareous, loamy soils on smooth uplands. These soils formed in eolian material that has been reworked by wind and water.

In a representative profile the surface layer consists of brown fine sandy loam about 13 inches thick. Below this is about 35 inches of reddish-brown fine sandy loam. The underlying material to a depth of 66 inches is reddish-brown fine sandy loam.

Mobeetie soils are well drained. Permeability is moderately rapid, and available water capacity is medium. Runoff is medium.

These soils are suited to native grass or to row crops. Almost all areas are used as range. The soils can be used for most locally grown crops and irrigated truck crops.

Representative profile of Mobeetie fine sandy loam, 0 to 3 percent slopes, about 10 miles west of Friona on Farm Road 1731, then 1.8 miles west on Farm Road 2013, then 0.5 mile south, in range; 1,340 feet east and 2,430 feet south of the northwest corner of sec. 14, Rhea Brothers, subdivision A:

A11—0 to 5 inches, brown (7.5YR 4/4) fine sandy loam, dark brown (7.5YR 3/4) moist; weak, coarse, subangular blocky to weak, fine, granular structure; slightly hard, very friable, slightly plastic; weak, very coarse, platy structure in top 2 inches; common fine roots; many fine and very fine pores and few medium pores; few worm casts; mildly alkaline; abrupt, smooth boundary.

A12—5 to 13 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) moist; weak, coarse, subangular blocky to weak fine granular structure; slightly hard, very friable, slightly sticky; many fine roots; many fine and very fine pores and few medium pores; mildly alkaline; few worm casts; abrupt, smooth boundary.

B2—13 to 26 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky and granular; hard, friable, slightly plastic; many fine roots; many fine and very fine pores and few medium pores; common worm casts; few faint threads and films of calcium carbonate; 10 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B3ca—26 to 48 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular blocky and granular; slightly hard, very friable, slightly plastic; many fine roots; many fine and very fine pores and few medium pores; few worm casts; few threads and films of calcium carbonate; 10 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

Cca—48 to 66 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; single grained and 20 percent weak, fine, subangular blocky structure; slightly hard, very friable, slightly plastic; few fine roots; many fine and very fine pores and few medium pores; few threads and films of calcium carbonate; 11 percent calcium carbonate, by volume; 8 percent calcium carbonate, by volume, in lower 6 inches; calcareous; moderately alkaline.

The solum ranges from 26 to 55 inches in thickness. It is fine sandy loam and is 12 to 18 percent clay. Calcium carbonates are at a depth of 0 to 13 inches. The A horizon is reddish brown or brown. The B horizon is yellowish brown, light yellowish brown, or reddish brown. The C horizon is brown, reddish brown, yellowish red, or light brown. The Cca horizon is 3 to 12 percent, by volume, calcium carbonate. Calcium carbonate concretions in the C horizon are a few, very fine, hard nodules, films, and threads of calcium carbonate.

Mobeetie fine sandy loam, 0 to 3 percent slopes (MoB).—This nearly level to gently undulating soil is on

plains that are ridged in some places. Areas are long and oval in shape and are parallel to areas of Likes loamy fine sand. The areas range from 10 to 250 acres in size, but they average more than 60 acres.

Included with this soil in mapping are small spots of Bippus soils and small dunes of Likes loamy fine sand.

This Mobeetie soil is in native grass. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Leaving crop residue on the surface helps to control soil blowing and erosion. In irrigated areas, a well-designed irrigation system is needed to control soil and water losses. In dryfarmed areas, farming on the contour and using terraces help to control erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–3, dryland, and IIIe–3, irrigated; Mixedland Slopes range site.

Olton Series

The Olton series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils on smooth uplands. These soils formed in loamy eolian material.

In a representative profile the surface layer is brown clay loam about 9 inches thick (fig. 15). The next layer is brown and reddish-brown clay loam about 19 inches thick. Below this is yellowish-red clay loam about 22 inches thick. The next layer to a depth of 76 inches is pinkish-white, calcareous clay loam.

***Figure 15.*—Profile of Olton clay loam showing the layer of maximum calcium carbonate accumulation that begins at a depth of about 50 inches.**

Olton soils are well drained. Permeability is moderately slow, and available water capacity is high. Runoff is very slow to slow.

These soils are well suited to native grass or to row crops. They can be used for irrigated truck crops. Cotton, corn, grain sorghum, wheat, soybeans, vegetables, and alfalfa are the main crops.

Representative profile of Olton clay loam, 0 to 1 percent slopes, 4 miles north of Lazbuddie on Farm Road 1172, then 0.5 mile west on a county road, on the north side of the road in an area of irrigated crops; 30 feet north and 2,000 feet west of the southeast corner of sec. 37, Kelly subdivision:

Ap—0 to 9 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak, medium, subangular blocky and granular structure; soft to slightly hard, very friable, slightly sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; few worm casts; neutral; abrupt, smooth boundary.

B21t—9 to 18 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate, medium and coarse, prismatic structure parting to weak, fine, subangular blocky and granular; very hard, friable, slightly sticky and plastic; many fine roots; common very fine and fine pores and few medium pores; few worm casts; thin patchy to almost continuous clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B22t—18 to 28 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate, medium and some fine, prismatic structure parting to moderate, medium, blocky; very hard, firm, slightly sticky, and plastic; many fine roots; common very fine and fine pores; very few worm casts; thin continuous clay films on faces of peds; calcareous; moderately alkaline; clear, smooth boundary.

B23tca—28 to 46 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; weak, medium, blocky structure; very hard, friable, slightly sticky and plastic; few fine roots; common very fine and fine pores; very few worm casts; continuous patchy clay films on faces of peds; few faint threads of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

B24tca—46 to 50 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; horizon slightly more sandy than horizon above; weak, medium, blocky structure; very hard, friable, slightly sticky and plastic; few fine roots; common very fine and fine pores; very few worm casts; continuous patchy clay films on faces of peds; few threads and fine concretions of calcium carbonate; calcareous; moderately alkaline; clear, wavy boundary.

B25tca—50 to 76 inches, pinkish-white (5YR 8/2) clay loam, reddish yellow (5YR 7/6) moist; weak, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; common patchy clay films on faces of peds, mostly masked by carbonates; medium and fine calcium carbonate concretions about same color as mass; 60 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum is 80 inches to more than 120 inches thick. Secondary soft carbonates are at a depth of 14 to 28 inches. Distinct carbonate horizons are at a depth of 30 to 56 inches. The A horizon is 6 to 13 inches thick and is brown, dark brown, or reddish brown. The B21t is dark brown, reddish brown, brown, grayish brown, or dark reddish gray. The B22t horizon is reddish-brown, yellowish-red, brown, or strong-brown clay loam. It is 35 to 42 percent clay. The Btca

is pink, pinkish white, reddish yellow, yellowish red, light reddish brown, or very pale brown. It is enriched with calcium carbonate.

Olton clay loam, 0 to 1 percent slopes (OtA).—This nearly level soil is on smooth plains. Areas range from 20 acres to several thousand acres in size. Slopes are less than 0.5 percent in most places. This soil has the profile described as representative of the Olton series.

Included with this soil in mapping are areas of Acuff, Estacado, and Pullman soils that are 5 acres or less in size. Oval areas of Acuff and Estacado soils are in most large areas of this Olton soil. Estacado soils are mostly small, round spots that make up less than 3 percent of most mapped areas and make up 15 percent in a few places. Areas of Pullman soils surround areas of this Olton soil. Also included are areas of soils that have been cultivated for several years and are more loamy in most places than other soils because some of the fine soil material has been removed from the surface layer. Some areas of soils that have a surface layer of loam or sandy clay loam are also included.

This Olton soil is suited to cultivation. Most areas are irrigated. Corn, grain sorghum, and wheat are the main crops (fig. 16). The hazards of soil blowing and erosion are slight. Runoff is very slow.

In dryfarmed areas, leaving crop residue on the surface helps to control soil blowing and erosion. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–6, dryland, and IIe–1, irrigated; Clay Loam range site.

Olton clay loam, 1 to 3 percent slopes (OtB).—This gently sloping soil is on uplands. Most areas are around playas and along draws, but some areas are on low ridges above the main level of the plains. Areas range from about 15 to 350 acres in size, but they average about 90 acres. Slopes are dominantly about 2 percent.

The surface layer is brown clay loam about 11 inches thick. The next layer to a depth of 37 inches is reddish-brown clay loam. Below this is about 17 inches of pink clay loam that is high in content of calcium carbonate. The next layer to a depth of 80 inches is reddish-yellow clay loam.

Included with this soil in mapping are small areas of Acuff and Estacado soils. Also included are some areas of soils that have a surface layer of loam or sandy clay loam.

***Figure 16.*—Harvesting wheat on Olton clay loam, 0 to 1 percent slopes. The heavy crop residue will help to prevent soil blowing and to conserve moisture.**

This Olton soil is used mostly for crops. Most cultivated areas are irrigated. A few areas are used as native range. The hazard of soil blowing is slight, and the hazard of erosion is moderate. Runoff is slow.

Leaving crop residue on the surface helps to control soil blowing and erosion. Using terraces and farming on the contour help to control erosion. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed.

Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–2, dryland, and IIIe–2, irrigated; Clay Loam range site.

Posey Series

The Posey series consists of deep, nearly level to sloping, calcareous, loamy soils on smooth uplands. These soils formed in calcareous, loamy, eolian material.

In a representative profile the surface layer is brown, calcareous fine sandy loam about 11 inches thick. The next layer is pink sandy clay loam about 12 inches thick. Below this to a depth of 80 inches is reddish-yellow sandy clay loam.

Posey soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is medium.

These soils are suited to row crops and native grass. They can be used for many kinds of irrigated truck crops. Alfalfa, corn, cotton, grain sorghum, soybeans, vegetables, and wheat are the main crops.

Representative profile of Posey fine sandy loam, 1 to 3 percent slopes, 3 miles west of Lariat on a county road, then 0.1 mile south in irrigated field; 2,000 feet west and 650 feet south of the northeast corner of sec. 48, blk. Z; W. D. and F. W. Johnson Survey:

Ap—0 to 11 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) moist; weak, subangular blocky and granular structure; slightly hard, very friable; many fine roots; many pores; few worm casts; few fine soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; abrupt, smooth boundary.

B21tca—11 to 23 inches, pink (7.5YR 7/4) sandy clay loam, brown (7.5YR 5/4) moist; weak, very coarse, prismatic structure parting to weak, medium, subangular blocky and granular; slightly hard, very friable, slightly sticky and plastic; many fine roots; many very fine and fine pores; many worm casts; few fine threads, films, soft masses, and concretions of calcium carbonate; 25 percent, by volume, calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B22tca—23 to 41 inches, reddish-yellow (5YR 7/6) sandy clay loam, reddish yellow (5YR 6/6) moist; weak, subangular blocky and granular structure; hard, friable, slightly sticky and plastic; common fine roots; many very fine and fine pores; 10 percent white concretions of calcium carbonate; few soft masses, threads, and films of calcium carbonate; 30 percent, by volume, calcium carbonate; calcareous; moderately alkaline; diffuse, wavy boundary.

B23tca—41 to 80 inches, reddish-yellow (5YR 7/6) sandy clay loam; yellowish red (5YR 5/6) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many very fine and fine pores; few fine concretions of calcium carbonate; calcareous; moderately alkaline.

Depth to the zone of distinct calcium carbonate accumulation ranges from 9 to 19 inches. The maximum visible carbonates are at a depth of 10 to 27 inches. The A horizon is 5 to 15 inches thick. It is brown, yellowish-red, dark grayish-brown, light reddish-brown, reddish-brown, or grayish-brown loam or fine sandy loam. The B21tca and B22tca horizons are pink, yellowish-red, reddish-yellow, brown, light-brown, reddish-brown, or light reddish-brown loam, sandy clay loam, or clay loam. They are 18 to 35 percent clay. The B21tca and B22tca horizons are 20 to 45 percent calcium carbonate, but they generally average 40 percent or less. The B23tca horizon is yellowish-red, reddish-yellow, or light reddish-brown sandy clay loam, clay loam, silty clay loam, or fine sandy loam.

Posey fine sandy loam, 0 to 1 percent slopes (PfA).—This soil is in slightly convex areas on smooth plains. Most areas are long and oval to irregular and oval in shape. They are more than 30 acres in size but range from 15 to 80 acres.

The surface layer is brown, calcareous fine sandy loam about 9 inches thick. The next layer is light-brown, calcareous sandy clay loam to a depth of 31 inches. Below this to a depth of 80 inches is reddish-yellow sandy clay loam.

Included with this soil in mapping are small areas of Amarillo and Tulia soils and a soil that is similar to this Posey soil, but it has a darker colored surface layer. Also included are a few small areas of soils that are eroded, a few areas of soils in which the upper few inches of the surface layer is noncalcareous, a few areas of soils in which the lower part of the profile is pale brown or yellowish brown, and a few areas of soils in which the surface layer is sandy clay loam or loam.

This Posey soil is used mostly for crops, but a few areas are in native range. Many cultivated areas are irrigated. The hazard of soil blowing is severe, and the hazard of erosion is moderate.

In dryfarmed areas, using terraces and farming on the contour help to conserve moisture and to control erosion. Leaving residue from such crops as corn, sorghum, or wheat on the surface helps to control soil blowing and erosion (fig. 17). In irrigated areas, using fertilizers, managing residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–3, dryland, and IIIe–4, irrigated; Mixedland Slopes range site.

Posey fine sandy loam, 1 to 3 percent slopes (PfB).—This sloping soil is in slightly convex, oblong bands on side slopes of playa basins and draws. Most areas are 300 to 1,000 feet wide and 1,000 feet to more than 8,000 feet long. They are about 40 acres in size, but range from 10 to 300 acres. Slopes average about 2 percent. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas of Amarillo and Tulia soils and a soil that is similar to this Posey soil, but it has a darker colored surface layer. Also included are many small areas of soils that are eroded, a few areas of soils in which the upper few inches of the surface layer is noncalcareous, a few areas of soils in which the lower part of the profile is pale brown or yellowish brown, and a few areas of soils in which the surface layer is sandy clay loam or loam.

This Posey soil is mostly cultivated, but a few small areas are in native range. Many cultivated areas are

Figure 17.—**Young grain sorghum planted in wheat stubble on Posey fine sandy loam, 0 to 1 percent slopes.**

irrigated. The hazard of soil blowing is severe, and the hazard of erosion is moderate.

Using terraces and farming on the contour help to control erosion. Leaving residue from such crops as corn or sorghum on the surface helps to control soil blowing and erosion. In irrigated areas, using fertilizer, managing residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed to maintain tilth. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–3, dryland, and IIIe–4, irrigated; Mixedland Slopes range site.

Posey-Berda complex, 5 to 8 percent slopes (PmD).—This complex is on foot slopes along draws and on side slopes of a few playa basins. It is about 50 percent Posey soils and soils that are similar to Posey soils, 35 percent Berda soils and soils that are similar to Berda soils, and 15 percent other soils. Most areas are about 50 acres in size, but areas range from 10 to 320 acres. The soils are in lower positions than Acuff, Estacado, Olton, and Pullman soils and in higher positions than Bippus and Spur soils.

Posey soils are in convex areas on the upper half of foot slopes. They have a surface layer of light reddish-brown fine sandy loam about 6 inches thick. The next layer is about 13 inches of light reddish-brown clay loam over about 19 inches of pink clay loam that is about 25 percent calcium carbonate. Next is reddish-yellow clay loam about 6 inches thick over 7 inches of pink clay loam that is about 38 percent calcium carbonate. Below this to a depth of 80 inches is yellowish-red clay loam.

Berda soils are in slightly concave areas on the lower part of side slopes. They have a surface layer of brown loam about 9 inches thick. The next layer is about 10 inches of brown loam that has many worm casts over about 9 inches of light reddish-brown loam. The underlying material is reddish-brown fine sandy loam that extends to a depth of 80 inches.

Included with these soils in mapping are areas of Bippus and Potter soils. Also included are a few areas of Posey soils that have a surface layer of clay loam, loam, or fine sandy loam and a few areas of Berda soils that have a surface layer of fine sandy loam or sandy clay loam.

The soils in this complex are used mostly as range. They are not suited to cultivation. A few small areas are in irrigated pasture. The hazard of soil blowing is moderate, and the hazard of erosion is severe.

In irrigated areas, a well-designed irrigation system

is needed. Areas that are in pasture need grazing management, fertilization, frequent irrigation, and rotation grazing. Capability unit VIe-2, dryland; Hardland Slopes range site.

Potter Series

The Potter series consists of gently sloping to strongly sloping, calcareous, loamy soils that are very shallow to shallow to caliche. These soils formed on uplands in caliche beds of knobs and knolls.

In a representative profile the surface layer is about 12 inches of brown loam that has a few caliche fragments. The next layer is white, weakly cemented to indurated caliche about 12 inches thick. Below this to a depth of about 64 inches is white weakly cemented caliche.

Potter soils are well drained. Permeability is moderate, and available water capacity is low. Runoff is medium to rapid.

These soils are suited to use as native range.

Representative profile of Potter loam, 3 to 12 percent slopes, 0.05 mile south of Bovina on Farm Road 1731, then 0.5 mile west on field road, in range; 2,100 feet west and 3,000 feet north of the southeast corner of sec. 21, T. 7 S., R. 2 E.:

A11—0 to 6 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak, medium, subangular blocky and granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine pores, common fine pores, and few medium pores; few worm casts; many very fine masses and concretions of calcium carbonate; few caliche fragments as much as ½ inch in diameter; 30 percent calcium carbonate, by volume; calcareous; moderately alkaline; clear, smooth boundary.

A12—6 to 12 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak, fine, subangular blocky and granular structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; many very fine pores, common fine pores, and few medium pores; few worm casts; many very fine masses and concretions of calcium carbonate; 20 percent, by volume, calcium carbonate fragments as much as 3 inches in diameter; 35 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, wavy boundary.

C1ca—12 to 24 inches, white (10YR 8/2) weakly cemented caliche to spots of indurated caliche, very pale brown (10YR 7/3) moist; some pendants of calcium carbonate on lower sides of indurated spots; few fine roots; common very fine and fine pores; 80 percent calcium carbonate, by volume; calcareous; moderately alkaline; clear, smooth boundary.

C2ca—24 to 64 inches, white (10YR 8/2) weakly cemented caliche, very pale brown (10YR 8/4) moist; soft masses of calcium carbonate; few fine roots; many very fine pores; 65 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The A horizon is 5 to 12 inches thick and is grayish brown or brown. It is 5 to 35 percent, by volume, caliche pebbles and fragments. The C1ca horizon is 50 to 95 percent pink to white, soft masses to cemented, platy fragments of calcium carbonate intermixed with calcareous loam to clay loam. In some places it is weakly cemented. The C2ca horizon ranges from slightly platy cemented caliche to soft caliche. In some places the Cca horizon is a thick bed of cemented, mainly somewhat platy caliche or caliche earth. The thick beds have more than 60 percent cemented to indurated, laminated caliche plates and stones. Some are 10 feet or more in thickness.

Potter loam, 3 to 12 percent slopes (PoE).—This gently sloping to strongly sloping soil is on knobs or knolls that protrude from side slopes along draws. Areas are in bands that are 400 to 6,000 feet long, are 100 to 800 feet wide, and follow the contour of draws. Most areas are 5 to 70 acres in size.

Included with this soil in mapping are small areas of Berda, Kimbrough, and Posey soils and some small spots of barren caliche outcrop. Also included are some areas of Potter soils that have a dark grayish-brown surface layer and a few spots of Potter soils that are 35 to 50 percent caliche fragments, by volume.

This Potter soil is not suited to cultivation. It is used mostly as range, but the grass cover is thin. This soil is a source of caliche in areas where the caliche beds are thick enough and are near the surface. Limitations are few for open pit mining. Caliche is mined in a few areas and used locally for roadbed material. Capability unit VIIs-1, dryland; Very Shallow range site.

Pullman Series

The Pullman series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils on broad, smooth uplands. These soils formed in eolian material.

In a representative profile the surface layer is brown clay loam about 9 inches thick. The next layer is brown, reddish-brown, and yellowish-red clay about 39 inches thick. Below this is about 31 inches of pink clay. The next layer to a depth of about 89 inches is reddish-yellow clay loam.

Pullman soils are well drained. Permeability is very slow, and available water capacity is high. Runoff is slow.

These soils are well suited to native grass or to row crops. They can be used for many kinds of irrigated truck crops. Cotton, corn, grain sorghum, wheat, soybeans, vegetables, and alfalfa are the main crops.

Representative profile of Pullman clay loam, 0 to 1 percent slopes, 1.1 miles east and 0.35 mile south of the northeast corner of Parmer County or 4 miles northeast of Black on U.S. Highway 60, then about 1.5 miles north on a county road; 100 feet east and 2,300 feet north of the southwest corner of sec. 3, blk. B.:

Ap—0 to 9 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak, coarse, subangular blocky and granular structure; hard, friable, sticky and plastic; few fine roots; common very fine pores; neutral; abrupt, smooth boundary.

B21t—9 to 13 inches, brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate, fine, subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; common very fine pores; few worm casts; continuous thin clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B22t—13 to 23 inches, brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate, medium and fine, blocky structure; extremely hard, firm, sticky and plastic; few decaying roots; few very fine pores; continuous clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B23t—23 to 34 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist; moderate, medium, blocky structure; very hard, firm, sticky and plastic; few fine roots; few very fine pores; few thin clay films on faces of peds; few threads, coatings, and fine concretions of calcium carbonate; calcareous; moderately alkaline; few noncalcareous spots; clear, smooth boundary.

B24t—34 to 48 inches, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; moderate, medium, blocky structure arranged in columns; very hard, friable,

sticky and plastic; few fine roots; few very fine pores; few thin clay films on faces of peds; few organic stains; few iron stains; few films, threads, and coatings of calcium carbonate; few fine cemented concretions of calcium carbonate; calcareous; moderately alkaline; few noncalcareous spots; clear, wavy boundary.

B25tca—48 to 79 inches, pink (5YR 8/3) clay, reddish yellow (5YR 7/6) moist; weak, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; few fine roots; few fine and very fine pores; few, fine, cemented concretions of calcium carbonate; 40 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, wavy boundary.

B26t—79 to 89 inches, reddish-yellow (5YR 7/6) clay loam, reddish yellow (5YR 6/6) moist; weak, medium, subangular blocky structure; friable, slightly sticky and plastic; many fine and very fine pores; few iron stains; few, fine, cemented concretions of calcium carbonate; 12 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum ranges from 80 inches to more than 120 inches in thickness. Secondary soft lime is at a depth of 15 to 28 inches. The A horizon is 5 to 11 inches thick. It is brown or dark grayish brown and ranges from neutral to moderately alkaline. The B21t and B22t horizons are brown or dark grayish brown. The B21t horizon is 4 to 15 inches thick. The B23t and B24t horizons are reddish-brown, yellowish-red, brown, or yellowish-brown clay. They are clay loam or silty clay loam at a lower depth in many places. The B25tca horizon is pink, light-brown, reddish-yellow, reddish-brown, yellowish-red, or brown clay to clay loam. The B25tca horizon is 30 to 70 percent, by volume, calcium carbonate, mainly soft masses and concretions. The B26t horizon is reddish-yellow, yellowish-red, reddish-brown, or pink clay loam or silty clay loam.

Pullman clay loam, 0 to 1 percent slopes (PuA).—This nearly level soil is in a nearly continuous area on a plain. This plain is dotted with playas and depressional areas and is interrupted by entrenched draws. The surface is very slightly convex in most areas. Slopes average about 0.3 percent and face in a southeasterly direction in most places. This soil has the profile described as representative of the Pullman series.

Included with this soil in mapping are areas of Estacado soils 1 to 3 acres in size and areas of Olton soils in broad transitional areas between Olton and Pullman soils. Also included in large areas of this Pullman soil are areas of Pullman clay loam, 1 to 3 percent slopes, that are 3 acres or less in size and areas of Randall clay that are less than 4 acres in size. These soils make up less than 5 percent of the mapped area. Some areas of Pullman soils that have a surface layer of silty clay loam are also included, mostly in areas of range.

This Pullman soil is well suited to large-scale farming, and nearly all areas are cultivated. Small grain and sorghums are the main crops (fig. 18). Alfalfa, cotton, sugar beets, and vegetables are also grown. A

***Figure 18.*—Harvesting corn for silage on Pullman clay loam, 0 to 1 percent slopes.**

few areas are in native range. The hazards of soil blowing and erosion are slight.

Terracing and contour farming are needed on long slopes to control erosion. Rotating crops and leaving crop residue on the surface help to control soil blowing and maintain soil tilth. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, using fertilizer, managing irrigation water in a well-designed irrigation system, and using a recovery system for runoff irrigation water are needed. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Capability units IIIe–5, dryland, and IIs–1, irrigated; Clay Loam range site.

Pullman clay loam, 1 to 3 percent slopes (PuB).—This gently sloping soil is mostly in broad bands that border playa basins and surround the larger basins. Areas are 10 to 250 acres in size. The surface is smooth and slightly convex. Slopes are mainly 1 to 2 percent.

The surface layer is brown clay loam 9 inches thick. The next layer is brown clay about 27 inches thick. Below this is 7 inches of yellowish-red clay loam. The next layer is pink clay loam about 37 inches thick. Below this is reddish-yellow clay loam.

Included with this soil in mapping are areas of Estacado and Olton soils that are less than 5 acres in size. Also included, in areas where water concentrates or on lower slopes, are eroded areas 3 to 4 acres in size. A few areas of soils that have a surface layer of silty clay loam are included in areas of range.

This Pullman soil is well suited to cultivation, and most areas are cultivated. A few areas are in native range. The hazard of soil blowing is slight, and the hazard of erosion is moderate.

In dryfarmed areas, using terraces and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control soil blowing and erosion and to maintain or improve soil tilth. Rough surface tillage helps to control soil blowing when crop residue is inadequate.

In irrigated areas, bench leveling or graded borders and a planned irrigation water management system help to control water and to prevent erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. A recovery system for runoff irrigation water is needed. Using fertilizer and returning a large amount of crop residue to the soil are also needed. Capability units IIIe–1, dryland, and IIIe–1, irrigated; Clay Loam range site.

Randall Series

The Randall series consists of deep, nearly level, noncalcareous, clayey soils on uplands. These soils formed in clayey material in concave playa depressions.

In a representative profile the surface layer is dark-gray clay about 18 inches thick. The next layer is about 44 inches of gray clay that has slickensides. The underlying material to a depth of 84 inches is light brownish-gray clay and light brownish-gray silty clay.

Randall soils are somewhat poorly drained. Permeability is very slow, and available water capacity is high. There is no runoff unless surface drainage is provided.

These soils are better suited to use as range than to most other uses. They are not cultivated unless some of the outside water is diverted or the playa can be drained. Row crops can be grown in areas that are drained, but the clay surface layer makes management difficult.

Representative profile of Randall clay, 9 miles north of Lazbuddie on Farm Road 1172, then 0.2 mile east on county road, then 0.2 mile northeast in range; 1,900 feet east and 1,400 feet north of the southwest corner sec. 16, T. 5½ S. R. 5 E.:

A1—0 to 18 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; 3 inches of dark grayish-brown clay loam at the top of horizon; weak, coarse, blocky structure parting to moderate, fine, blocky; extremely hard, very firm, very sticky and plastic; pressure faces on surface of peds; few very dark grayish-brown cemented concretions 2 millimeters in diameter; mildly alkaline; diffuse, wavy boundary.

AC1—18 to 43 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, fine and medium, blocky structure; extremely hard, very firm, very sticky and plastic; wedge-shaped parallelepipeds that have long axis tilted about 30 degrees from the horizontal; pressure faces on surface of peds; few, fine, round, dark-brown concretions; intersecting slickensides; calcareous; moderately alkaline; diffuse, wavy boundary.

AC2—43 to 62 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak, medium, blocky and subangular blocky structure; extremely hard, very firm, very sticky and plastic; few pressure faces; fewer wedge-shaped peds than in AC1 horizon; few dark-brown concretions, black inside; calcareous; moderately alkaline; diffuse, smooth boundary.

C1—62 to 77 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; massive; extremely hard, very firm, very sticky and plastic; few grayish-brown concretions, black inside; calcareous; moderately alkaline; diffuse, smooth boundary.

C2—77 to 84 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; massive; very hard, firm, sticky and plastic; calcareous; moderately alkaline.

Depth to loam material is more than 6 feet in most places; near the edge of playas, it is generally more than 40 inches. The A horizon varies in thickness as the microrelief varies. It is 6 inches thick in the center of knolls and more than 25 inches in depressions. It is mostly dark gray but is gray or very dark gray in a few places. The AC horizon is gray, dark gray, or grayish brown. The C horizon is brown, light brownish gray, light gray, or yellowish red. It is mostly clay, but it is silty clay or sandy clay loam to fine sandy loam in some places. In a few playas the C horizon is fine sand.

Randall clay (Ra).—This deep soil is in concave and oval areas on flat-bottomed playas. Most areas are 5 to 75 acres in size, but some are smaller. Slopes are as much as 0.2 percent along the edges of playas. This soil is well distributed throughout the county. It makes up about 1 percent of the landscape along the western boundary of the county and more than 2 percent in the eastern part.

Included with this soil in mapping are areas of Randall soils that have a few inches of overwash of clay loam, sandy clay loam, or silty clay loam. These included soils are in areas where all surrounding soils are cultivated or drainageways flow into the playa. The loamy material is in cracks at least 20 inches deep in some places. Also included is a calcareous soil that makes up about 5 to 10 percent of the mapped area.

This soil is not suited to cultivation, unless it is drained. During wet seasons, it is covered with a few

inches to several feet of water that stands for several months in places. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Cattle do not graze the flooded playas, but these areas provide habitat for waterfowl and other wildlife. During extremely wet seasons, all vegetation except sedge and smartweed is drowned. Capability unit VIw–1, dryland; included in range site of surrounding soils.

Spur Series

The Spur series consists of deep, nearly level, calcareous, loamy soils. These soils formed in calcareous loamy alluvium in drainageways.

In a representative profile the surface layer is brown, calcareous loam about 11 inches thick. The next layer is light-brown, calcareous clay loam about 17 inches thick. The underlying material to a depth of about 80 inches is grayish-brown and light-gray clay loam.

Spur soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is slow.

These soils are used mostly as native range. A few areas are planted to irrigated grasses. The soils are flooded at least once every 4 to 10 years.

In Parmer County, Spur soils are mapped only in undifferentiated units with Bippus soils.

Representative profile of Spur loam in an area of Bippus and Spur soils, frequently flooded, 5 miles east of Hub on Texas Highway 86, then 4.5 miles south on a county road, on the west side of the road, in range; 875 feet west and 3,800 feet south of the northeast corner of sec. 15, Kelly subdivision:

A1—0 to 11 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak, coarse, subangular blocky and granular structure; slightly hard, friable, slightly sticky; many fine roots; many very fine, fine, and medium pores; many worm casts; calcareous; moderately alkaline; gradual, smooth boundary.

B2—11 to 28 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 4/4) moist; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky and granular; slightly hard, friable, slightly sticky and plastic; many fine roots; many very fine, fine, and medium pores; many worm casts; few, fine, soft lumps and concretions of calcium carbonate; few threads and films of calcium carbonate in lower part; few layers of slightly darker clay loam ½ to 1 inch thick between clay loam; calcareous; moderately alkaline; gradual, smooth boundary.

C1—28 to 61 inches, grayish-brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; common fine pores; few worm casts; few, fine, soft lumps and concretions of calcium carbonate; many threads and few films of calcium carbonate; some slightly lighter and darker layers; 15 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

C2—61 to 67 inches, light-gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) moist; weak, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; common fine and very fine pores; films of calcium carbonate on all peds; few threads of calcium carbonate; few, fine, soft lumps and concretions of calcium carbonate; 15 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

C3—67 to 80 inches, light-gray (10YR 7/1) clay loam, grayish brown (10YR 5/2) moist; weak, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; common fine and very fine pores; films of calcium carbonate on all peds; few threads of calcium carbonate; few, fine, soft lumps and concretions of calcium carbonate; 20 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum ranges from 28 to 60 inches in thickness. The A horizon is 11 to 19 inches thick and is brown, dark grayish brown, or dark brown. The B horizon is brown, light brown, or reddish brown. It ranges from clay loam to sandy clay loam and is 25 to 35 percent clay. The C horizon is brown, grayish brown, very pale brown, light yellowish brown, light gray, white, pinkish white, pinkish gray, or reddish brown. This horizon is less clayey than the A and B horizons. It ranges from clay loam to sandy clay loam and has some fine sandy loam and loamy sand at greater depths.

Tulia Series

The Tulia series consists of deep, nearly level to gently sloping, calcareous, loamy soils on smooth upland plains. These soils formed in calcareous, loamy, eolian material.

In a representative profile the surface layer is grayish-brown loam about 9 inches thick over light brownish-gray clay loam about 8 inches thick (fig. 19). The next layer to a depth of 63 inches is very pale

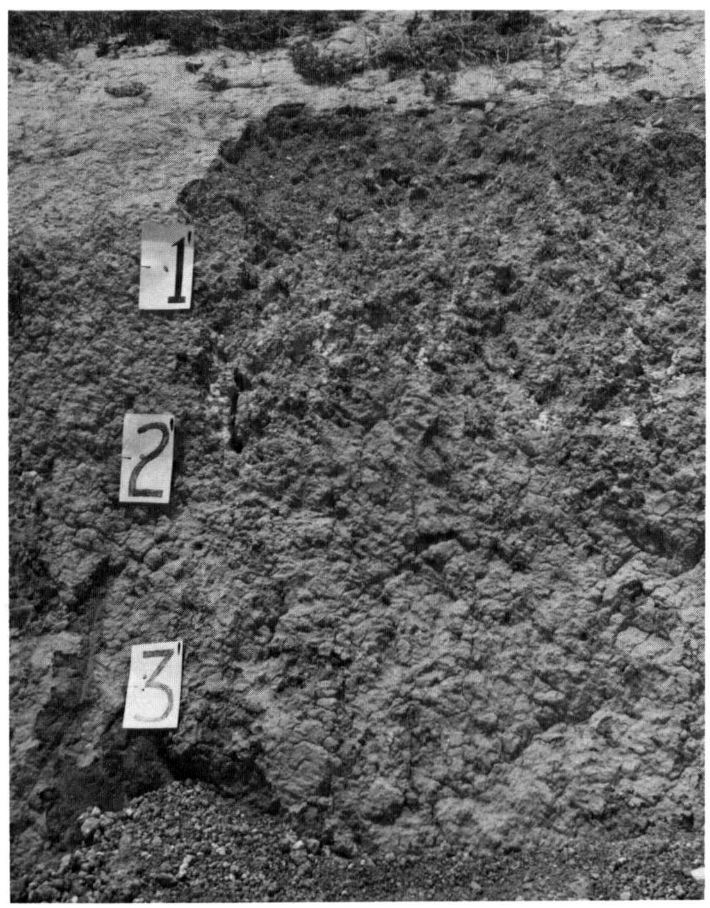

***Figure 19.*—Profile of Tulia loam. This soil is high in content of carbonates.**

brown and reddish-yellow clay loam. Below this to a depth of about 94 inches is yellowish-red clay loam.

Tulia soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is slow to medium.

These soils are used for row crops and native grass. Cotton, corn, grain sorghum, wheat, and alfalfa are the main crops. In cultivated areas the high lime content in the soils causes plant chlorosis.

Representative profile of Tulia loam, 1 to 3 percent slopes, 1 mile south of Friona on Texas Highway 214 and 0.9 mile east on a field road, in an irrigated area of crops; 20 feet south and 650 feet west of the northeast corner of sec. 18, T. 4 S., R. 4 E.:

Ap—0 to 9 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; weak, fine, subangular blocky and granular structure; slightly hard, friable, slightly sticky and plastic; few fine roots; many very fine pores, common fine pores, and few medium pores; few worm casts; few, very fine, soft masses and concretions of calcium carbonate; 21 percent calcium carbonate, by volume; calcareous; moderately alkaline; clear, smooth boundary.

A1—9 to 17 inches, light brownish-gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky and weak, fine, granular; hard, friable, slightly sticky and plastic; few fine roots; many very fine, fine, and medium pores; many worm casts; few, very fine, soft masses and concretions of calcium carbonate; 54 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B21ca—17 to 36 inches, very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many very fine, fine, and medium pores; common worm casts; 10 percent medium soft masses and concretions of calcium carbonate; 78 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, wavy boundary.

B22tca—36 to 63 inches, reddish-yellow (5YR 6/6) clay loam, yellowish red (5YR 5/6) moist; moderate, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many very fine, fine, and medium pores; few worm casts; few patchy clay films on faces of peds, mostly in lower part; large pockets 3 inches or more across of soft calcium carbonate; medium soft masses and concretions of calcium carbonate; few threads of calcium carbonate in lower part; 50 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, wavy boundary.

B23tca—63 to 94 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate, medium, subangular blocky and blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many very fine and fine pores; continuous clay films on faces of peds in noncalcareous part of horizon; 5 percent medium to coarse soft masses and concretions of calcium carbonate; 29 percent calcium carbonate, by volume; ranges from noncalcareous in spots 3 to 6 inches in diameter and interior of some peds to calcareous; moderately alkaline.

The zone of distinct calcium carbonate accumulation is at a depth of 5 to 16 inches. Maximum visible carbonates are at a depth of 9 to 25 inches. The A horizon is brown, light-brown, light reddish-brown, or grayish-brown loam or fine sandy loam. The B21ca and B22tca horizons are light reddish-brown, pale-brown, very pale brown, pinkish-gray, pinkish-white, pink, or reddish-yellow clay loam. They are 27 to 35 percent clay and are 30 to 80 percent calcium carbonate. The B23tca horizon is light reddish-brown, reddish-brown, reddish-yellow, or yellowish-red clay loam to sandy clay loam.

Tulia loam, 0 to 1 percent slopes (TuA).—This nearly level soil is on plains in irregularly shaped spots or patches that are within large areas of Estacado clay loam in most places. Areas range from 10 to 60 acres in size, but they average more than 30 acres. The surface is slightly convex or level.

The surface layer is brown loam about 11 inches thick. The next layer is light-brown clay loam about 6 inches thick. Below this to a depth of about 50 inches is pink clay loam. The next layer to a depth of about 80 inches is reddish-yellow clay loam.

Included with this soil in mapping are areas of soils that have clay films within 20 inches of the soil surface and areas of soils that have a surface layer of clay loam. Also included are a few spots of Potter soils and some areas of soils that have a dark-brown surface layer and make up no more than 5 percent of the mapped area.

This Tulia soil is mostly cultivated. An equal amount of the cultivated areas is irrigated and dryfarmed. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Leaving residue from such crops as small grain and sorghums on the surfaces helps to control erosion and maintain soil tilth. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Growing perennial grasses helps to control erosion. In irrigated areas, fertilizers are needed to maintain soil tilth and crop production. A well-designed irrigation system helps to control soil and water losses. Capability units IVe–2, dryland, and IIIe–4, irrigated; Hardland Slopes range site.

Tulia loam, 1 to 3 percent slopes (TuB).—This gently sloping soil is on smooth slopes around playa basins and along draws. Areas are oval in shape and are 5 to 40 acres in size, but they average 15 acres. This soil has the profile described as representative of the Tulia series.

Included with this soil in mapping are areas of a soil that is similar to this Tulia soil, but it has clay films within 20 inches of the surface. This soil makes up as much as 15 percent of some mapped areas. Also included are some areas of soils that have a dark-brown surface layer and some areas of soils that have a surface layer of clay loam. Some spots of soils that have a considerable amount of caliche gravel or indurated caliche flags on the surface and some small spots of soils that have a subsurface layer of indurated caliche at a depth of 10 to 20 inches are also included.

This Tulia soil is mostly cultivated with other adjoining soils. The hazards of soil blowing and erosion are moderate.

The main concerns in management are controlling erosion and using fertilizer effectively in irrigated areas. Erosion can be controlled by growing perennial grasses or legumes. Alfalfa is well suited as an irrigated crop. Sorghums, wheat, or other crops can be grown. Leaving crop residue on the surface helps to control soil blowing. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Terraces or benches and contour farming help to con-

trol erosion. Capability unit IVe–2, dryland, and IIIe–4, irrigated; Hardland Slopes range site.

Tulia-Potter complex, 1 to 5 percent slopes (TwC).—This complex is 85 percent Tulia soils and 15 percent Potter soils. These gently sloping soils are on smooth, convex bands that mostly border playa basins but also border draws. Most areas range from 5 to 35 acres in size, but they average about 15 acres.

The Tulia soil is in areas surrounding the Potter soil. It has a surface layer of brown fine sandy loam about 5 inches thick. The next layer is 4 inches of light-brown sandy clay loam over 19 inches of pink sandy clay loam. Below this is 18 inches of reddish-brown clay loam. The next layer is light reddish-brown clay loam about 34 inches thick.

The Potter soil is on the middle or upper, steeper, more convex slopes. It has a surface layer about 9 inches thick of brown loam that has many caliche fragments and pebbles and a few other fragments. The underlying material is weakly cemented, white caliche about 12 inches thick.

Included with these soils in mapping are eroded spots, small gravelly areas, and a few outcrops of indurated, laminated caliche. Also included are areas of Kimbrough soils 1 acre to 2 acres in size.

These soils are used mainly for range. Some areas are cultivated. The hazard of soil blowing is moderate, and the hazard of erosion is severe.

In dryfarmed areas, using terraces and farming on the contour help to control erosion. Leaving crop residue on the surface from such crops as corn or sorghum helps to control soil blowing and erosion. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Tillage helps to control soil blowing when crop residue is inadequate. Capability units IVe–3, dryland, and IVe–2, irrigated; Hardland Slopes range site.

Zita Series

The Zita series consists of moderately deep, nearly level, noncalcareous, loamy soils on uplands. These soils formed in eolian material.

In a representative profile the surface layer is brown loam about 7 inches thick. Below this is brown clay loam about 13 inches thick and light brownish-gray clay loam about 10 inches thick. The next layer is light-gray sandy clay loam about 25 inches thick. Below this is white clay loam that extends to a depth of about 80 inches.

Zita soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is very slow.

These soils are well suited to native grass or to row crops. They can be used for many kinds of irrigated truck crops. Cotton, corn, grain sorghum, wheat, soybeans, vegetables, and alfalfa are the main crops.

Representative profile of Zita loam, 0 to 1 percent slopes, 5 miles south of Lazbuddie on a county road, then 1 mile west on another county road, on the south side of the road in irrigated pasture; 115 feet west and 150 feet south of the northeast corner of sec. 16, E. A. Warren, blk. W.:

Ap—0 to 7 inches, brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate, fine, granular structure; hard, very friable, slightly plastic; many very fine roots; many very fine and fine pores and few medium pores; few worm casts; mildly alkaline; abrupt, smooth boundary.

B2—7 to 20 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; common worm casts; calcareous; moderately alkaline; clear, smooth boundary.

B2ca—20 to 30 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; few worm casts; few films and threads and few, fine, soft masses and concretions of calcium carbonate; 15 percent calcium carbonate, by volume; calcareous; moderately alkaline; clear, smooth boundary.

C1ca—30 to 55 inches, light-gray (10YR 7/1) sandy clay loam, light brownish gray (10YR 6/2) moist; massive; very hard, friable, slightly sticky and plastic; many fine roots; many very fine and fine pores; many threads, fine soft masses, and concretions of calcium carbonate; 20 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, smooth boundary.

C2ca—55 to 80 inches, white (10YR 8/1) clay loam, light gray (10YR 7/1) moist; massive; very hard, friable, slightly sticky and plastic; few fine roots; many fine and very fine pores; 45 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum is 30 to 50 inches thick. Free calcium carbonate is at a depth of 12 to 24 inches, and maximum carbonate accumulation is at a depth of 20 to 40 inches. The A horizon is 7 to 14 inches thick. It is brown, dark brown, or dark grayish brown and is mildly alkaline or moderately alkaline. The B2 and B2ca horizons and the upper part of the C1 horizon to a depth of more than 40 inches are mostly clay loam but range to loam and average 25 to 35 percent clay. The B2 horizon is brown, light brownish gray, pale brown, light brown, or grayish brown. The B2ca horizon is light brownish gray, light gray, or white and is 15 to 60 percent, by volume, calcium carbonate. The C horizon is white, light-gray, pinkish-white, or pinkish-gray sandy clay loam or clay loam.

Zita loam, 0 to 1 percent slopes (ZcA).—This nearly level soil is on slightly concave benches of larger playas. Areas are oval to crescent in shape. Most areas range from 15 to 100 acres in size, but they average slightly more than 40 acres.

Included with this soil in mapping are areas of a soil similar to Zita soil, but it has clay films in the lower layers. Also included are some areas of similar soils that have surface layers of fine sandy loam or clay loam.

Most areas of this Zita soil are irrigated. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Leaving crop residue on the surface helps to control soil blowing and erosion. In irrigated areas, using fertilizer helps to maintain soil fertility and crop production. A well-designed irrigation system is needed to control soil and water losses. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–6, dryland, and IIe–1, irrigated; Clay Loam range site.

Use and Management of the Soils

This section explains the system of capability grouping used by the Soil Conservation Service and briefly describes the soils in each capability unit. It gives predicted yields of dryland and irrigated crops under a high level of management for the arable soils in the county. It also gives suggestions on management of the soils for range, wildlife habitat, and windbreaks and tells about the use of the soils in engineering and recreational development.

Capability Grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. These readers can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on permanent limitations of soils when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclass indicates major kinds of limitations within the classes. Within most of the classes there can be as many as four subclasses. The subclasses are indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in some parts of the United States but not in Parmer County, indicates that the chief limitation is climate that is too cold or too dry.

Class I has no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion. These soils have other limitations, however, that restrict their use largely to pasture, range, wildlife habitat, or recreational purposes.

Subclasses are further divided into groups called capability units. These are groups of soils that are enough alike that they are suited to the same crops and pasture plants, they require about the same management, and they have generally similar productivity and other response to management. Capability units are generally identified by numbers assigned locally, for example, IIe–1 or IIIs–4.

The eight classes in the capability system and the subclasses and the units in Parmer County are described in the list that follows. The unit designation is given in the "Guide to Mapping Units."

DRYLAND CAPABILITY UNITS

Class I. Soils have few limitations that restrict their use. (None in Parmer County.)

Class II. Soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

- Subclass IIe. Soils are subject to moderate erosion if they are not protected.
  - Unit IIe–1. Deep, moderately permeable, nearly level, noncalcareous clay loams on bottom lands.

Class III. Soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.

- Subclass IIIe. Soils are subject to severe erosion if they are cultivated and not protected.
  - Unit IIIe–1. Deep, very slowly permeable, gently sloping, noncalcareous clay loams on uplands.
  - Unit IIIe–2. Deep, moderately permeable to moderately slowly permeable, gently sloping, calcareous to noncalcareous loams to clay loams on uplands and bottom lands.
  - Unit IIIe–3. Deep to moderately deep, moderately permeable to moderately rapidly permeable, nearly level to gently sloping, calcareous to noncalcareous fine sandy loams on uplands and bottom lands.
  - Unit IIIe–4. Deep, moderately permeable, nearly level, noncalcareous loams on uplands.
  - Unit IIIe–5. Deep, very slowly permeable, nearly level, noncalcareous clay loams on uplands.
  - Unit IIIe–6. Deep to moderately deep, moderately permeable to moderately slowly permeable, calcareous to noncalcareous clay loams to loams on uplands.

Class IV. Soils have very severe limitations that reduce the choice of plants or require very careful management, or both.

- Subclass IVe. Soils are subject to very severe erosion if they are cultivated and not protected.
  - Unit IVe–1. Deep, moderately permeable, gently sloping, noncalcareous loams on uplands.
  - Unit IVe–2. Deep, moderately permeable, nearly level to gently sloping, calcareous loams on uplands.

Unit IVe–3. Deep to very shallow, moderately permeable, gently sloping, calcareous to noncalcareous fine sandy loams to loams on uplands.

Unit IVe–4. Deep, moderately permeable, gently sloping, calcareous loams on uplands.

Subclass IVw. Soils are very severely limited for cultivation because of excess water.

Unit IVw–1. Deep, very slowly permeable, nearly level, calcareous clays in upland depressions.

Class V. Soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range or wildlife habitat.

Subclass Vw. Soils are flooded too frequently for cultivation; drainage or protection is not feasible.

Unit Vw–1. Deep, moderately permeable, nearly level, noncalcareous to calcareous clay loams to loams on bottom lands.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range or wildlife habitat.

Subclass VIe. Soils are severely limited, mainly by risk of erosion if protective cover is not maintained.

Unit VIe–1. Deep, moderately rapidly permeable, gently sloping to sloping and undulating, calcareous loamy fine sands on uplands.

Unit VIe–2. Deep, moderately permeable, sloping, calcareous loams to fine sandy loams on uplands.

Subclass VIw. Soils are too poorly drained for cultivation; drainage is not feasible.

Unit VIw–1. Deep, very slowly permeable, nearly level, noncalcareous clays in upland depressions.

Class VII. Soils have very severe limitations that make them unsuited to cultivation and restrict their use largely to range or wildlife habitat.

Subclass VIIs. Soils are very severely limited because of very shallow depth.

Unit VIIs–1. Very shallow to shallow, moderately permeable, gently sloping to strongly sloping, calcareous loams on uplands.

Class VIII. Soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, and water supply or to esthetic purposes. (None in Parmer County.)

IRRIGATED CAPABILITY UNITS

Class I. Soils have few limitations that restrict their use. (None in Parmer County.)

Class II. Soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Subclass IIe. Soils are subject to moderate erosion if they are not protected.

Unit IIe–1. Deep to moderately deep, moderately permeable to moderately slowly permeable, nearly level, calcareous to noncalcareous loams to clay loams on uplands and bottom lands.

Unit IIe–2. Deep to moderately deep, moderately permeable, nearly level, noncalcareous fine sandy loams on uplands and bottom lands.

Subclass IIs. Soils have moderate limitations because permeability is very slow.

Unit IIs–1. Deep, very slowly permeable, nearly level, noncalcareous clay loams on uplands.

Class III. Soils have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Subclass IIIe. Soils are subject to severe erosion if they are cultivated and not protected.

Unit IIIe–1. Deep, very slowly permeable, gently sloping, noncalcareous clay loams on uplands.

Unit IIIe–2. Deep, moderately permeable to moderately slowly permeable, gently sloping, calcareous to noncalcareous loams and clay loams on uplands and bottom lands.

Unit IIIe–3. Deep, moderately permeable to moderately rapidly permeable, nearly level to gently sloping, noncalcareous fine sandy loams on uplands.

Unit IIIe–4. Deep, moderately permeable, nearly level to gently sloping, calcareous fine sandy loams to loams on uplands.

Unit IIIe–5. Deep, moderately permeable, gently sloping, noncalcareous loams on uplands.

Class IV. Soils have very severe limitations that reduce the choice of plants or require very careful management, or both.

Subclass IVe. Soils are subject to very severe erosion if they are cultivated and not protected.

Unit IVe–1. Deep, moderately permeable, gently sloping, noncalcareous fine sandy loams on uplands.

Unit IVe–2. Deep to very shallow, moderately permeable, gently sloping, calcareous loams on uplands.

Subclass IVs. Soils are very severely limited because permeability is very slow.

Unit IVs–1. Deep, very slowly permeable, nearly level, calcareous clays in upland depressions.

Predicted Yields

The predicted yields of the principal crops grown in Parmer County are given in table 2. The predictions are based on estimates made by farmers, soil scientists, and others who have knowledge of yields in the county and on information taken from research data. The predicted yields are average yields per acre that can be expected by good commercial farmers at the level of management that tends to produce the highest economic returns.

The yields are given for both dryland and irrigated soils if the soils are used for both methods of farming. If only one method is practical, yields for only this method of farming are given. Not included in this

TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*

[Only the soils commonly used for crops are listed. Absence of data indicates that the particular crop is not grown on the soil specified]

Soil	Dry farmed			Irrigated			
	Wheat	Grain sorghum	Cotton	Wheat	Grain sorghum	Cotton	Alfalfa
	Bu	*Lb*	*Lb*	*Bu*	*Lb*	*Lb*	*Tons*
Acuff loam, 0 to 1 percent slopes	18	1,250	200	55	7,400	850	6
Acuff loam, 1 to 3 percent slopes	15	1,100	175	50	6,600	800	5
Acuff loam, 3 to 5 percent slopes	10	1,000	150				
Amarillo fine sandy loam, 0 to 1 percent slopes	15	1,250	200	55	7,200	850	5
Amarillo fine sandy loam, 1 to 3 percent slopes	13	1,000	175	50	6,400	750	4
Amarillo fine sandy loam, 3 to 5 percent slopes	10	800	150				3
Arvana fine sandy loam, 0 to 1 percent slopes	15	1,000	200	50	7,000	850	4
Berda loam, 3 to 5 percent slopes	10	800		35	3,600		
Bippus fine sandy loam, 0 to 1 percent slopes	20	1,250	250	55	7,200	850	5
Bippus clay loam, 0 to 1 percent slopes	15	1,200	225	55	7,400	800	6
Bippus clay loam, 1 to 3 percent slopes	12	1,000	200	50	6,600	800	5
Estacado clay loam, 0 to 1 percent slopes	15	1,200	175	55	7,400	850	5
Estacado clay loam, 1 to 3 percent slopes	15	1,100	150	45	6,000	800	4
Estacado-Posey complex, 3 to 5 percent slopes	10	500		30	3,500		3
Friona loam, 0 to 1 percent slopes	15	1,150	200	55	7,300	800	5
Lipan clay, depressional	15	850		45	5,700	700	5
Mobeetie fine sandy loam, 0 to 3 percent slopes	15	1,250	200	50	6,400	750	4
Olton clay loam, 0 to 1 percent slopes	15	1,100	200	55	7,600	850	6
Olton clay loam, 1 to 3 percent slopes	15	1,000	175	50	6,400	800	5
Posey fine sandy loam, 0 to 1 percent slopes	15	1,250	200	55	7,000	800	5
Posey fine sandy loam, 1 to 3 percent slopes	15	1,250	175	50	6,200	700	4
Pullman clay loam, 0 to 1 percent slopes	15	1,250	175	55	7,600	850	6
Pullman clay loam, 1 to 3 percent slopes	15	1,000	160	45	6,700	800	5
Tulia loam, 0 to 1 percent slopes	10	1,000	150	45	6,200	750	4
Tulia loam, 1 to 3 percent slopes	10	1,000	150	40	6,000	700	4
Tulia-Potter complex, 1 to 5 percent slopes	10	650		25	3,000	350	3
Zita loam, 0 to 1 percent slopes	15	1,000	200	55	7,300	850	5

table are soils that are used only as range or for recreational purposes.

Crops other than those shown in table 2 are grown in the county, but they are not listed because their acreage is small or reliable data on yields are not available.

The predicted yields given in table 2 can be expected if the following management practices are used:

For dryland—

1. Rainfall is effectively used and conserved.
2. Crop residue is managed to maintain soil tilth.
3. Tillage is minimal but timely.
4. Insect, disease, and weed control measures are consistently used.
5. Fertilizer is applied according to soil test and crop needs.
6. Suited crop varieties are used at recommended seeding rates.

For irrigated areas the following additional practices are used—

7. A suitable quality of irrigation water is used.
8. Irrigation is timed to meet the need of the soil and crop.
9. Irrigation systems are properly designed and efficiently used.

Most of the irrigated soils are clay loams, loams, or fine sandy loams. The infiltration rate, or the rate water enters the soils, determines the length of irrigation runs that the farmers use in most places. The smooth areas that dominate the High Plains are well suited to furrow irrigation. Most areas require only a little land leveling or smoothing before they are irrigated. Sprinkler irrigation systems are also used, mostly on loams and fine sandy loams. Water is pumped from irrigation wells into open ditches or underground pipelines. These ditches or pipelines convey the water to the high ends of fields, where it is turned into furrows. Some of the more sloping areas are leveled and irrigated by the border and furrow methods.

The wells draw water from the Ogallala Formation from depths of 100 to 450 feet, with pump setting averaging about 160 feet. The rate of pumping ranges from about 100 to 1,400 gallons per minute and averages about 700 gallons per minute. This water is of high quality. At present, there seems to be little or no recharge from rainfall, and water is being pumped out faster than it is being restored. According to representatives of the High Plains Underground Water District, who study the decline of the water table by observing wells, the decline ranges from 2 to 8 feet per year. The first irrigation wells were drilled during the early part of the 1940's. The number of wells increased slowly until the first part of the 1950's. Then the drought of the fifties emphasized the need for supplemental irrigation, and the number of irrigation wells increased rapidly. An estimated 3,435 wells cur-

rently are furnishing water to about 410,000 irrigated acres.

Grain sorghum, wheat, and cotton are the main irrigated crops in Parmer County, but smaller areas are used for corn, forage sorghum, sorghum silage, corn silage, soybeans, castor beans, irrigated pasture grasses, sugar beets, and vegetables.

The amount of vegetables grown in the county has been increasing in recent years. Vegetables are mostly grown in areas that are close to processing or packing sheds, although some are marketed at a considerable distance from farms.

The main vegetable crops are potatoes, lettuce, carrots, onions, cucumbers, cabbage, peppers, and cantaloups. Sugar beets are grown, and smaller areas are used for spinach, beans, pumpkins, eggplant, tomatoes, and watermelons. Average yields per acre on Pullman clay loam and Olton clay loam under good management are:

Potatoes (100-pound sacks)	190
Lettuce (cartons)	550
Carrots (tons)	10
Onions (50-pound sacks)	500
Cucumbers (pounds)	20,000
Cabbage (tons)	10
Tomatoes (pounds)	17,000

Yields are usually slightly less on Estacado and Acuff soils. A crop of potatoes is commonly followed by wheat or another small grain.

Fertilizer is added to nearly all of the irrigated crops in Parmer County. The amount added is based on previous cropping history, soil tests, results of research, and the farmer's production goal. Technicians of the Soil Conservation Service or Agricultural Extension Service will assist farmers in planning fertilization programs. In most places irrigated soils are relatively low in nitrogen and phosphorus but high in potash.

Range [2]

About 9 percent of Parmer County is in native range. Four ranching units are 960 acres to 6,400 acres in size. Approximately 30 units that are 40 to 320 acres in size have some acreage in range. These areas of range are used with cultivated areas, which produce sorghums and wheat for grazing.

Range sites and condition classes

Soils differ in their capacity to produce grass and other plants for grazing. Soils that produce about the same kind and amount of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of rangeland that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind and amount of climax vegetation. The climax vegetation consists of the plants that were growing on any given site when the region was first settled. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax vegetation.

[2] By JOHN A. WRIGHT, area range conservationist, Soil Conservation Service, Amarillo, Texas.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable decreaser plants are reduced by close grazing. They are commonly shorter than decreasers and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. Range condition class indicates the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in *excellent* condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in *good* condition if the percentage is 51 to 75; in *fair* condition if the percentage is 26 to 50; and in *poor* condition if the percentage is less than 25.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the climax plant community for that site.

The potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep range in excellent or good condition. If this is done, water is conserved, yields are improved, and the soils are protected. The main concern is recognizing important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long term trend is toward lower production. On the other hand, a range area that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of the range sites

In this section the eight range sites of Parmer County are described, and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential average annual acre yield of air-dry herbage in favorable and unfavorable years for each site where it is in excellent condition. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

CLAY LOAM RANGE SITE

This range site is made up of deep to moderately deep, nearly level to gently sloping clay loams and

loams on uplands. Permeability is moderate to very slow, and available water capacity is medium or high. Runoff is very slow to medium. The hazard of soil blowing is slight to moderate, and the hazard of erosion is slight to severe. In many places the intake of moisture is reduced by surface crusting, and downward movement of moisture is slowed by compacted layers, or hoofpans.

The climax plant community is mainly short grasses and a few mid grasses. Its composition, by percentage of total weight, is approximately 50 percent blue grama, 20 percent buffalograss; 5 percent side-oats grama; 5 percent galleta or tobosagrass; 5 percent western wheatgrass; 5 percent vine-mesquite; 5 percent bluestem; and 5 percent perennial forbs.

If the site is continuously heavily grazed by cattle, blue grama, side-oats grama, western wheatgrass, and vine-mesquite decrease or disappear. Buffalograss, perennial three-awn, sand dropseed, and annual weeds increase. Cholla, pricklypear, and yucca invade.

Where this site is in excellent condition, the average annual acre yield of air-dry forage ranges from 2,400 pounds in wet years and 1,000 pounds in dry years. About 95 percent of this forage can be used by cattle.

HARDLAND SLOPES RANGE SITE

This range site is made up of deep, nearly level to strongly sloping loams and fine sandy loams to clay loams on uplands. Permeability is moderate, and available water capacity is medium. Runoff is medium to slow. The hazards of soil blowing and erosion are moderate to severe.

The climax plant community is a mixture of short and mid grasses and a small amount of yucca and forbs. Its composition, by percentage of total weight, is approximately 35 percent side-oats grama; 25 percent blue grama; 5 percent vine-mesquite; 5 percent little bluestem; 5 percent buffalograss; 5 percent silver bluestem; 5 percent Wright three-awn; 5 percent sand dropseed; 5 percent woody plants; and 5 percent perennial forbs.

If the site is continuously heavily grazed by cattle, side-oats grama, blue grama, vine-mesquite, and little bluestem decrease. Buffalograss, silver bluestem, sand dropseed, Wright three-awn, and yucca increase. Annual weeds invade.

Where this site is in excellent condition, the average annual acre yield of air-dry herbage is 2,200 pounds in wet years and 1,200 pounds in dry years. About 95 percent of this forage can be used by cattle.

LAKEBED RANGE SITE

Lipan clay, depressional, is the only soil in this site. This deep, nearly level soil is on benches above playa bottoms. Permeability is very slow, and available water capacity is high. Runoff is slow. The hazard of soil blowing is moderate, and the hazard of erosion is slight. This soil is flooded once in 3 to 10 years.

The climax plant community varies considerably among playa lakes and is dependent upon size, inundation periods, and available runoff. Some areas are virtually bare, some are 100 percent sedges, and others are 100 percent western wheatgrass. Still others have 10 or 12 different kinds of plants, many of which are annuals. The climax plant community in the larger playa lakes is mainly forbs and some short grasses. The composition, by percentage of total weight, is approximately 20 percent bur ragweed; 20 percent large spikesedge; 15 percent beakpod evening primrose; 15 percent Belvedere summer-cypress; 15 percent slimleaf goosefoot; 5 percent prostrate knotweed; 5 percent buffalograss; and 5 percent blue grama.

If the site is continuously heavily grazed, particularly during the growing season of April through July, most of the forbs decrease. Such plants as buffalograss, bluegrama, and little barley increase. Plant composition and production on this site are more dependent on available moisture, rainfall, and runoff accumulation than on grazing pressure.

Where this site is in excellent condition, the average annual acre yield of air-dry herbage is 3,500 pounds in wet years and 500 pounds in dry years. About 100 percent of this forage can be used by cattle.

MIXEDLAND SLOPES RANGE SITE

This range site is made up of steep, nearly level to sloping fine sandy loams. Permeability is moderate to moderately rapid, and available water capacity is medium. Runoff is medium. The hazard of soil blowing is moderate to severe, and the hazard of erosion is slight to severe.

The climax plant community is mainly short, mid, and tall grasses. Its composition, by percentage of total weight, is approximately 30 percent side-oats grama; 20 percent blue grama; 10 percent little bluestem; 10 percent sand bluestem; 10 percent indiangrass; 5 percent buffalograss; 5 percent hairy grama; 5 percent small soapweed; and 5 percent perennial forbs.

If the site is continuously heavily grazed by cattle, side-oats grama, blue grama, little bluestem, and sand bluestem decrease. Buffalograss, hairy grama, three-awns, sand dropseed, and annual weeds increase. Sand sagebrush and cholla invade.

Where this site is in excellent condition, the average annual acre yield of air-dry herbage is 2,200 pounds in wet years and 1,500 pounds in dry years. About 95 percent of this forage can be used by cattle.

SANDY RANGE SITE

Likes loamy fine sand, 1 to 8 percent slopes, is the only soil in this site. This deep soil is gently sloping to sloping and undulating. Permeability is moderately rapid, and available water capacity is low. Runoff is slow. The hazard of soil blowing is severe, and the hazard of erosion is slight.

The climax plant community is a mixture of tall and mid grasses and sand plum and shin oak. Its composition, by percentage of total weight, is approximately 20 percent side-oats grama; 15 percent sand bluestem; 15 percent little bluestem; 10 percent switchgrass; 10 percent hairy grama; 5 percent indiangrass; 5 percent needle-and-thread; 5 percent blue grama; 5 percent other perennial grasses; 5 percent woody plants; and 5 percent perennial forbs.

If the site is continuously heavily grazed by cattle, sand bluestem, switchgrass, little bluestem, side-oats grama, and indiangrass decrease. Blue grama, hairy grama, sand dropseed, three-awn, and sand sagebrush increase. Red lovegrass, gummy lovegrass, tumble lovegrass, and annual weeds invade.

Where the site is in excellent condition, the average annual acre yield of air-dry herbage is 3,000 pounds in wet years and 1,500 pounds in dry years. Cattle use about 90 percent of this herbage.

SANDY LOAM RANGE SITE

This range site is made up of deep to moderately deep, nearly level to gently sloping fine sandy loams.

Permeability is moderate, and available water capacity is low to high. Runoff is slow to medium. The hazard of soil blowing is moderate, and the hazard of erosion is slight to moderate.

The climax plant community is a mixture of short, mid, and tall grasses and woody shrubs and forbs. Its composition, by percentage of total weight, is approximately 25 percent blue grama; 15 percent side-oats grama; 10 percent buffalograss; 5 percent little bluestem; 5 percent sand bluestem; 5 percent indiangrass; 5 percent silver bluestem; 20 percent other perennial grasses; 5 percent sand sagebrush; and 5 percent perennial forbs.

If the site is continuously heavily grazed by cattle, side-oats grama, blue grama, little bluestem, sand bluestem, indiangrass, and switchgrass decrease. Buffalograss, sand dropseed, silver bluestem, hairy grama, three-awns, catsclaw, sand sagebrush, and annual forbs increase. Mesquite, catsclaw, and some annuals invade.

Where this site is in excellent condition, the average annual acre yield of air-dry herbage is 2,400 pounds in wet years and 1,400 pounds in dry years. About 90 percent forage can be used by cattle.

VALLEY RANGE SITE

This range site is made up of deep, nearly level to gently sloping loams and clay loams to fine sandy loams on bottom lands (fig. 20). Permeability is moderate, and available water capacity is high. Runoff is slow to medium. The hazards of soil blowing and erosion are slight to moderate. Some areas of these soils are flooded at least once in 4 to 10 years. Most areas are not flooded.

The climax plant community is mainly short and mid grasses. Its composition, by percentage of total weight, is approximately 20 percent blue grama; 15 percent vine-mesquite; 15 percent buffalograss; 10 percent side-oats grama; 10 percent western wheatgrass; 5 percent alkali sacaton; 5 percent other perennial grasses; 10 percent woody plants; and 10 percent perennial forbs.

If the site is continuously heavily grazed by cattle, side-oats grama, blue grama, vine-mesquite, and west-

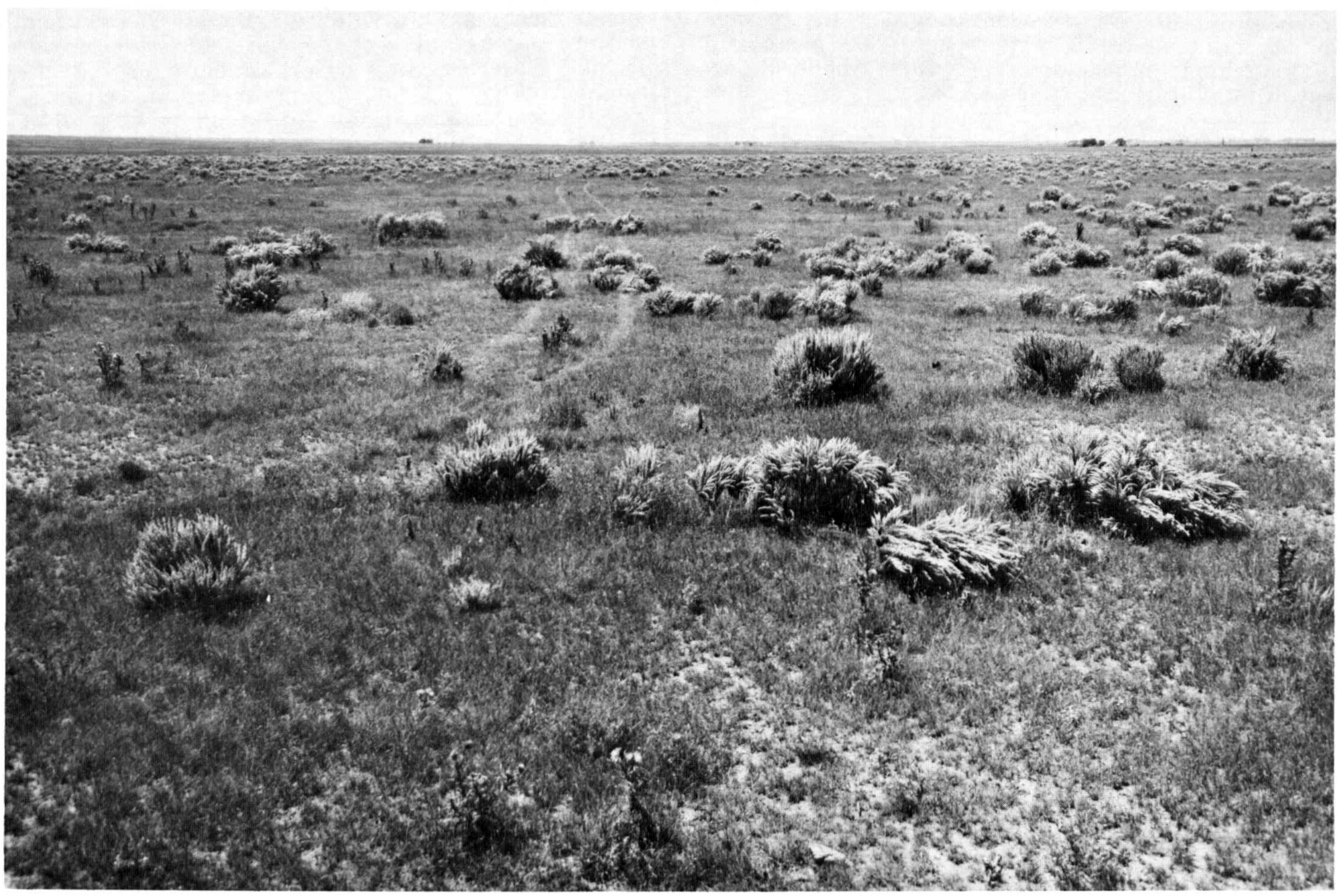

***Figure 20.*—Bippus fine sandy loam in Valley range site.**

ern wheatgrass decrease. Such plants as buffalograss, three-awns, and silver bluestem increase. Cactus and annual weeds invade.

Where this site is in excellent condition, the average annual acre yield of air-dry herbage is 2,600 pounds in wet years and 1,800 pounds in dry years. Approximately 80 percent of this forage can be used by cattle.

VERY SHALLOW RANGE SITE

This range site is made up of very shallow to shallow, gently sloping to strongly sloping loams on uplands. Permeability is moderate, and available water capacity is very low to low. Runoff is slow to rapid. The hazards of soil blowing and erosion are slight.

The climax plant community is a mixture of mid and tall grasses and perennial forbs. Its composition, by percentage of total weight, is approximately 25 percent side-oats grama; 10 percent little bluestem; 10 percent blue grama; 5 percent sand bluestem; 5 percent indiangrass; 5 percent switchgrass; 25 percent other perennial grasses; 10 percent woody plants; and 5 percent perennial forbs.

If the site is continuously heavily grazed by cattle, sand bluestem, switchgrass, indiangrass, and side-oats grama decrease. Hairy grama, Wright three-awn, sand dropseed, silver bluestem, and annual forbs increase. Hairy tridens and annuals invade.

Where this site is in excellent condition, the average annual acre yield of air-dry herbage is 800 pounds in wet years and 400 pounds in dry years. About 80 percent of this forage can be used by cattle.

Wildlife [3]

Soils in Parmer County support many kinds of wildlife habitats. Such game birds as bobwhite quail, scaled quail, dove, and ring-necked pheasant are found in the range and cultivated areas. Several different kinds of nongame birds inhabit the county. Small mammals common to the county are jackrabbit, cottontail rabbit, badger, ground squirrel, raccoon, opossum, prairie dog, rat, and mice. Predators common to the area are swift fox, coyote, and different kinds of hawks.

At one time, deer, antelope, and bison inhabited the county. As the county became settled, however, overhunting and destruction of their habitat eliminated these big game animals.

Farm ponds and a few playa lakes, which have water pumped into them, are the only fishery resources in the county. These water areas are generally stocked with catfish. They attract waterfowl during the migration season (fig. 21).

Soils directly influence the kind and amount of vegetation and the amount of water available. In this way they indirectly influence the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are (1) thickness of soil useful to crops, (2) texture of the surface layer, (3) available water capacity to a depth of 40 inches, (4) wetness, (5) surface stoniness or rockiness, (6) hazard of flooding, (7) slope, and (8) permeability of the soil to air and water.

[3] By ALLEN R. VAUGHN, biologist, Soil Conservation Service, Amarillo, Texas.

In table 3, the soils of Parmer County are rated according to their suitability for producing six elements of wildlife habitat and for three groups, or kinds, of wildlife. The ratings indicate relative suitability for various elements. A rating of *good* indicates that habitat is generally easily created, improved, or maintained. The soil has few or no limitations that affect management, and satisfactory results can be expected when the soil is used for the prescribed purpose.

A rating of *fair* indicates that habitat can be created, improved, or maintained in most places, but the soil has moderate limitations that affect management or development. A moderate intensity of management and fairly frequent attention may be required to insure satisfactory results.

A rating of *poor* indicates that habitat can be created, improved, or maintained in most places, but the soil has severe limitations. Management is difficult, expensive, and requires intensive effort. Results are questionable.

A rating of *very poor* indicates that under the prevailing soil conditions, it is impractical to attempt to create, improve, or maintain habitat. Soil limitations are very severe, and unsatisfactory results are probable.

Each soil is rated in table 3 according to its suitability for producing various kinds of plants and other elements that make up wildlife habitats. The ratings take into account mainly the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of soils, or present distribution of wildlife and people. For this reason, selection of the site for development as a habitat for wildlife requires inspection at the site.

The six elements of wildlife habitat rated in table 3 are briefly defined in the following paragraphs.

Grain and seed crops are crops that produce annual grain, such as corn, sorghum, oats, millet, sunflower, and soybeans.

Grasses and legumes are domestic grasses and legumes that are established by planting. They provide food and cover for wildlife. Grasses include ryegrass, switchgrass, and western wheatgrass; legumes include alfalfa, hairy vetch, and sweet clovers.

Wild herbaceous upland plants are native or introduced perennial grasses, forbs, and weeds that provide food and cover for upland wildlife. Ground cherry, lamb's quarter, ragweed, and wild ryegrass, are examples of these plants. On range typical plants are bluestem, grama, perennial forbs, and legumes.

Shrubs produce buds, twigs, bark, or foliage used as food by wildlife or that provide cover and shade for some kinds of wildlife. Catsclaw, plum, Russian-olive, sagebrush, and skunkbush sumac are typical kinds of plants in this category.

Wetland food and cover plants are annual and perennial herbaceous plants that grow wild on moist and wet sites. They furnish food and cover mostly for wetland wildlife. Typical examples of plants are aneilema, burreed, sedges, smartweed, spikerush and other rushes, and tearthumb. Submerged and floating aquatics are not included in this category.

Shallow water developments are impoundments or excavations for controlling water, generally not more

Figure 21.—**Waterfowl on an intermittent playa lake on Randall clay.**

than 5 feet deep, to create habitats that are suitable for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments that grow submersed aquatics.

Table 3 also rates soils according to their suitability as habitat for the three kinds of wildlife in the county —open-land, rangeland, and wetland wildlife. These ratings are related to ratings made for the elements of wildlife habitat. For example, soils rated very poor for shallow water developments are rated very poor for wetland wildlife. The kinds of wildlife for which the soils are rated in table 3 are briefly described in the following paragraphs.

Open-land wildlife consists of birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, pheasant, dove, meadowlark, jackrabbit, field sparrow, and fox are typical examples of open-land wildlife.

Rangeland wildlife consists of birds and mammals that normally live in areas of native grasses, forbs, and shrubs. Ground squirrel, prairie dog, coyote, and cottontail rabbit are typical examples of rangeland wildlife.

Wetland wildlife consists of birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, coots, gulls, killdeer, curlew, plover, and cranes are typical examples of wetland wildlife. In table 3 each of the soils are rated as poor or very poor. However, some of these soils would be rated fair to good for wetland wildlife if irrigation water were made available for management of these areas.

TABLE 3.—*Suitability of soils for elements of wildlife habitat and kinds of wildlife*

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Shrubs	Wetland food and cover plants	Shallow water developments	Open-land	Rangeland	Wetland [1]
Acuff: AcA, AcB, AcC	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Amarillo: AmA, AmB, AmC	Fair	Good	Fair	Good	Poor	Very poor	Fair	Fair	Very poor.
Arvana: ArA	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Berda:									
BeC	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
BeD	Poor	Fair	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Bippus:									
BfA	Good	Good	Good	Good	Poor	Very poor	Good	Good	Very poor.
BpA	Good	Good	Fair	Fair	Poor	Very poor	Good	Fair	Very poor.
BpB	Fair	Good	Good	Fair	Poor	Very poor	Good	Fair	Very poor.
Bs. For Spur part, see Spur series.	Very poor	Poor	Fair	Good	Poor	Very poor	Poor	Fair	Very poor.
Estacado: EsA, EsB, EtC. For Posey part of EtC, see Posey series, PfA.	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Friona: FrA	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Kimbrough: KmC	Very poor	Very poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor.
Likes: LkD	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Fair	Very poor.
Lipan: Lp	Fair	Fair	Fair	Poor	Very poor	Poor	Fair	Poor	Very poor.
Mobeetie: MoB	Fair	Good	Fair	Good	Poor	Very poor	Fair	Fair	Very poor.
Olton: OtA, OtB	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Posey:									
PfA, PfB	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
PmD. For Berda part, see Berda series, BeD.	Poor	Fair	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Potter:									
PoE	Very poor	Very poor	Poor	Fair	Very poor	Very poor	Very poor	Poor	Very poor.
Potter part of TwC	Very poor	Very poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor.
Pullman: PuA, PuB	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Randall: Ra	Poor	Poor	Poor	Very poor	Poor	Fair	Poor	Very poor	Poor.
Spur: Mapped only with Bippus soils.	Good	Good	Good	Good	Poor	Fair	Good	Good	Very poor.
Tulia: TuA, TuB, TwC. For Potter part of TwC, see Potter series.	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.
Zita: ZcA	Fair	Good	Fair	Fair	Poor	Very poor	Fair	Fair	Very poor.

[1] Many of these soils will rate fair or good instead of very poor if available irrigation water is used to develop shallow water areas.

Windbreaks

Trees and shrubs are used to form windbreaks around farmsteads or feedlots as well as for esthetic purposes (fig. 22). They beautify the farmstead, protect it from blowing soil and snow, and reduce the velocity of wind. Windbreaks around feedlots protect livestock and make them more comfortable. Trees planted near farmsteads provide nesting and roosting places for many songbirds.

In Parmer County the best trees for windbreaks are introduced species that are planted as seedlings. The soils in the county will support trees if they are watered from time to time. Chinese elm and eastern redcedar are suited to soils such as Olton and Pullman soils. Chinese elm, eastern redcedar, and ponderosa pine are suited to Acuff and Berda soils. Russian-olive, wild plum, desert-willow, and similar shrubs are used in windbreaks and for food and cover in wildlife sanctuaries.

Information on planning windbreaks, proper spacing, and selection of trees and shrubs can be obtained from representatives of the Soil Conservation Service, technicians assisting the Soil and Water Conservation District, or from other qualified specialists.

Engineering Uses of the Soils [4]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can

[4] DAN C. HUCKABEE, area engineer, Soil Conservation Service, assisted in preparing this section.

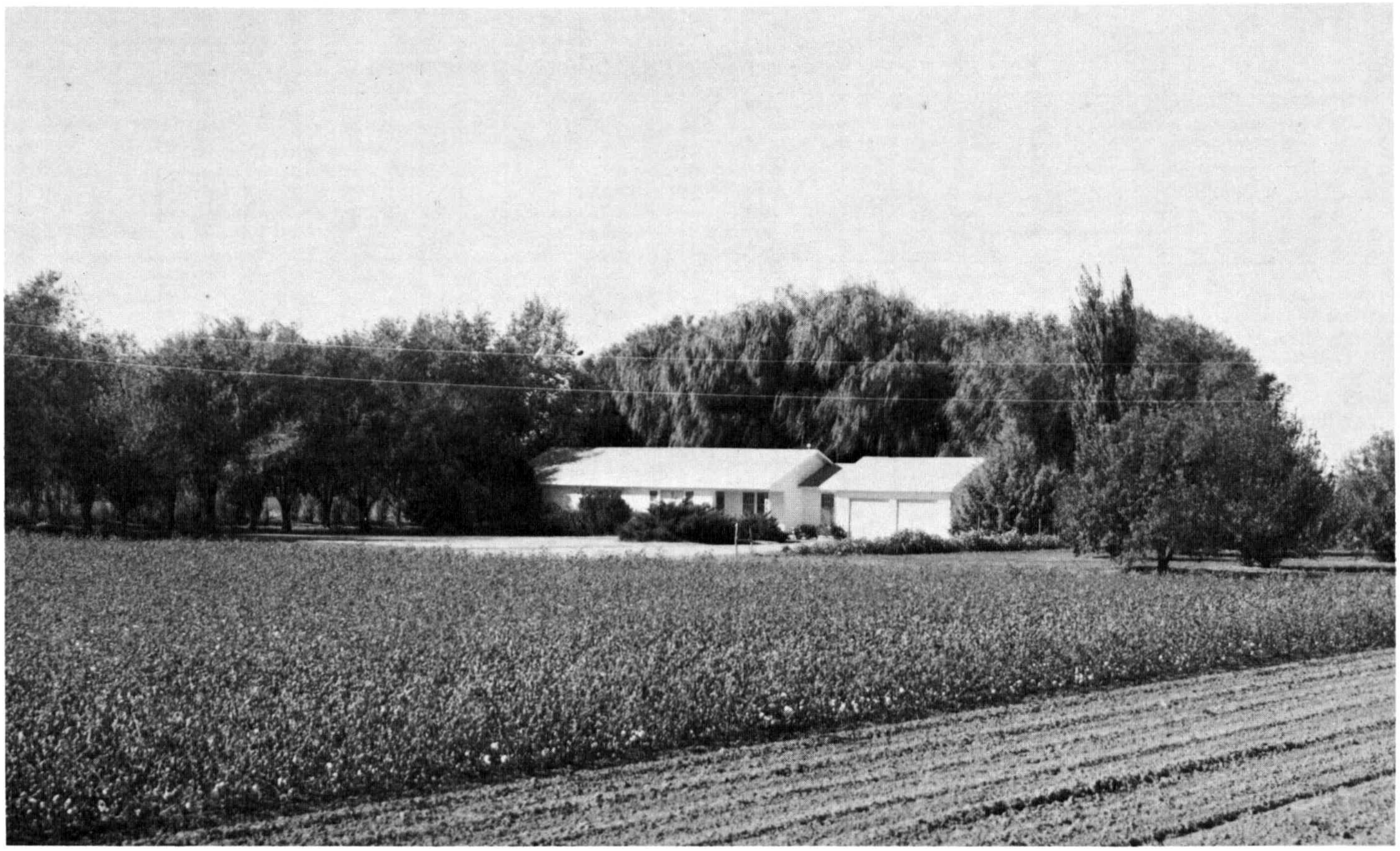

Figure 22.—**Farmstead windbreak of Chinese elm, poplar, desert-willow, and some fruit trees on Olton soils.**

benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the soil properties most important in engineering are permeability, shear strength, compaction characteristics, compressibility, soil drainage condition, shrink-swell potential, grain-size distribution, plasticity, and reaction. Depth to the water table, depth to bedrock, and slope are also important. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4 and 5 which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in table 5, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to a depth greater than those shown in the tables, generally a depth of more than 6 feet. In addition, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have

TABLE 4.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soils. fully the instructions for referring to other series that appear in the first column of this table.

Soil series and map symbols	Hydrologic group	Depth from surface	Dominant USDA texture	Classification		Percentage passing sieve—	
				Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
		In					
Acuff: AcA, AcB, AcC	B	0–11	Loam	CL	A–4 or A–6	100	100
		11–40	Sandy clay loam	CL	A–6 or A–7–6	100	100
		40–80	Sandy clay loam	CL	A–6	95–100	90–100
Amarillo: AmA, AmB, AmC	B	0–9	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	100	100
		9–44	Sandy clay loam	SC, CL, SM–SC, or CL–ML	A–6, A–4	100	100
		44–102	Sandy clay loam	SC or CL	A–6, A–4	90–100	90–99
Arvana: ArA	C	0–7	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	100	100
		7–26	Sandy clay loam	SC or CL	A–4 or A–6	100	100
		26–75	Indurated and soft caliche.				
		75–90	Sandy clay loam	CL, SC, CL–ML, or SM–SC	A–4 or A–6	95–100	90–100
Berda: BeC, BeD	B	0–6	Loam	SC or CL	A–4 or A–6	90–100	85–100
		6–36	Loam	SC or CL	A–4 or A–6	95–100	95–100
		36–80	Fine sandy loam	SM, ML, CL–ML, or SM–SC	A–4	90–99	85–95
*Bippus:							
BfA	B	0–10	Fine sandy loam	SM, SC, ML, CL, SM–SC, or CL–ML	A–2–4 or A–4	100	90–100
		10–30	Sandy clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
		30–40	Clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
		40–54	Fine sandy loam	SM, SC, ML, CL, SM–SC, or CL–ML	A–2–4 or A–4	100	90–100
		54–80	Sandy clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
BpA, BpB, Bs. For Spur part of Bs, see Spur series.	B	0–19	Clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	95–100
		19–66	Clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
*Estacado: EsA, EsB, EtC. For Posey part of EtC, see Posey series.	B	0–13	Clay loam	CL	A–6 or A–4	100	98–100
		13–28	Clay loam	CL	A–6 or A–7–6	95–100	95–100
		28–90	Clay loam	CL	A–6 or A–7–6	95–100	95–100
Friona: FrA	C	0–8	Loam	CL	A–4 or A–6	100	100
		8–31	Sandy clay loam	CL	A–6 or A–7–6	100	100
		31–35	Indurated caliche.				
		35–84	Sandy clay loam	CL	A–4 or A–6	95–100	90–100

significant in engineering

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
The symbol < means less than. Absence of data indicates that no estimate was made]

Percentage passing sieve—Contd.		Liquid limit	Plasticity index	Permeability [1]	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to uncoated steel
No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				In per hr	*In per in of soil*	*pH*		
95–100	51–70	25–32	8–15	0.6–2.0	0.14–0.17	6.6–7.8	Low	Moderate.
95–100	65–75	30–45	15–25	0.6–2.0	0.15–0.18	7.4–8.4	Moderate	Moderate.
90–100	60–70	25–35	13–20	0.6–2.0	0.12–0.15	7.9–8.4	Low	Moderate.
95–100	35–49	<25	[2] NP–2	2.0–6.0	0.11–0.15	6.6–7.3	Low	Moderate.
95–100	36–65	25–36	7–20	0.6–2.0	0.15–0.17	7.4–8.4	Low	Moderate.
80–95	36–60	20–32	8–15	0.6–2.0	0.11–0.15	7.9–8.4	Low	Moderate.
70–85	30–49	<25	NP–7	2.0–6.0	0.10–0.14	7.4–7.8	Low	Moderate.
80–90	36–65	20–35	8–20	0.6–2.0	0.13–0.17	7.4–8.4	Low	Moderate.
80–90	36–65	20–35	4–15	0.6–2.0	0.07–0.15	7.9–8.4	Low	Moderate.
80–95	36–70	20–35	8–20	0.6–2.0	0.14–0.17	7.9–8.4	Low	Moderate.
80–95	40–70	20–35	8–20	0.6–2.0	0.14–0.17	7.9–8.4	Low	Moderate.
80–95	36–65	<25	NP–7	2.0–6.0	0.10–0.14	7.9–8.4	Very low	Moderate.
85–98	30–60	<25	NP–10	2.0–6.0	0.10–0.15	7.9–8.4	Very low	Moderate.
80–100	36–75	20–40	7–20	0.6–2.0	0.14–0.20	7.9–8.4	Low	Moderate.
80–100	36–75	20–40	7–20	0.6–2.0	0.14–0.20	7.9–8.4	Low	Moderate.
85–98	30–60	<25	NP–20	2.0–6.0	0.10–0.15	7.9–8.4	Very low	Moderate.
80–100	36–75	20–40	7–20	0.6–2.0	0.14–0.20	7.9–8.4	Low	Moderate.
80–100	40–85	20–40	7–20	0.6–2.0	0.15–0.20	7.4–7.8	Low	Moderate.
80–100	36–75	20–40	7–20	0.6–2.0	0.14–0.20	7.9–8.4	Low	Moderate.
95–100	50–85	25–40	8–25	0.6–2.0	0.14–0.18	7.9–8.4	Moderate	Moderate.
85–100	55–90	30–42	12–25	0.6–2.0	0.12–0.16	7.9–8.4	Moderate	Moderate.
95–100	60–95	30–45	13–25	0.6–2.0	0.13–0.17	7.9–8.4	Moderate	Moderate.
90–100	51–70	25–35	8–15	0.6–2.0	0.14–0.18	6.6–7.8	Low	Moderate.
90–100	60–75	30–45	15–25	0.6–2.0	0.13–0.17	7.4–8.4	Moderate	Moderate.
90–100	51–75	20–35	10–20	0.6–2.0	0.10–0.15	7.9–8.4	Low	Moderate.

TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Hydrologic group	Depth from surface	Dominant USDA texture	Classification		Percentage passing sieve—	
				Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
		In					
Kimbrough: KmC	D	0–8	Loam	GM, GC, SM, SM–SC, SC, GM–GC	A–2–4 or A–4, A–1	55–85	50–80
		8–60	Indurated caliche, gravel, cobbles, and stones.				
Likes: LkD	A	0–9	Loamy fine sand	SM, SM–SC	A–2–4	90–98	90–98
		9–62	Fine sand	SM, SM–SC, or SP–SM	A–2–4, A–3	95–98	95–97
Lipan: Lp	D	0–48	Clay	CH	A–7–6	95–100	95–100
		48–70	Clay	CL or CH	A–7–6	95–100	95–100
Mobeetie: MoB	B	0–66	Fine sandy loam	SM, SM–SC, ML, CL–ML	A–4	95–98	90–95
Olton: OtA, OtB	C	0–9	Clay loam	CL	A–4 or A–6	100	95–100
		9–50	Clay loam	CL	A–6 or A–7–6	100	90–100
		50–76	Clay loam	CL	A–6	90–100	90–100
*Posey: PfA, PfB, PmD. For Berda part of PmD, see Berda series.	B	0–11	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	98–100	95–100
		11–41	Sandy clay loam	SC, CL, CL–ML, or SM–SC	A–4 or A–6	85–100	90–98
		41–80	Sandy clay loam	CL	A–4 or A–6	95–100	90–95
Potter: PoE	C	0–12	Loam	ML or CL	A–4 or A–6	80–95	70–90
		12–64	Weakly cemented to indurated caliche.	GM, GC, SM, or SC	A–2, A–4, or A–6	30–80	25–75
Pullman: PuA, PuB	D	0–9	Clay loam	CL	A–7–6, A–6	100	100
		9–48	Clay	CL or CH	A–7–6	100	100
		48–89	Clay and clay loam.	CL	A–4 or A–6	95–100	90–100
Randall: Ra	D	0–84	Clay	CL or CH	A–7–6	100	100
Spur: Mapped only with Bippus soils.	B	0–11	Loam	CL	A–4 or A–6, A–7–6	100	95–100
		11–80	Clay loam	CL	A–4, or A–6	100	95–100
*Tulia: TuA, TuB	B	0–17	Loam and clay loam.	CL, SC, SM–SC, or CL–ML	A–4 or A–6	95–100	90–100
		17–94	Clay loam	CL, SC	A–4 or A–6	90–100	90–100
TwC. For Potter part, see Potter series.	B	0–5	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	95–100	90–100
		5–46	Sandy clay loam and clay loam.	CL	A–4 or A–6	95–100	90–100
		46–80	Clay loam	CL, SC	A–4 or A–6	90–100	90–100
Zita: ZcA	B	0–7	Loam	CL	A–4 or A–6	100	100
		7–30	Clay loam	CL	A–6 or A–7–6	98–100	98–100
		30–55	Sandy clay loam	SC or CL	A–6, A–4	90–100	90–99
		55–80	Clay loam	CL	A–6	90–100	80–90

[1] These ratings should not be confused with the coefficient "k" used by engineers.

significant in engineering—Continued

Percentage passing sieve—Contd.		Liquid limit	Plasticity index	Permeability [1]	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to uncoated steel
No. 40 (0.42 mm)	No. 200 (0.074 mm)							
				In per hr	*In per in of soil*	*pH*		
40–65	20–40	<30	NP–10	0.6–2.0	0.10–0.15	7.9–8.4	Low	Moderate.
75–95	12–30	<25	NP–6	2.0–6.0	0.06–0.10	7.9–8.4	Very low	Low.
70–90	9–25	<25	NP–6	6.0–20.0	0.04–0.08	7.9–8.4	Very low	Low.
95–100	85–95	50–70	35–50	<0.06	0.15–0.20	7.9–8.4	Very high	High.
90–100	80–95	41–60	25–40	<0.06	0.15–0.20	7.9–8.4	Very high	High.
80–95	40–65	<25	NP–7	2.0–6.0	0.10–0.14	7.4–8.4	Very low	Low.
85–100	55–75	20–35	8–15	0.6–2.0	0.15–0.20	6.6–7.3	Low	Moderate.
90–100	70–85	35–50	15–30	0.2–0.6	0.15–0.20	7.4–8.4	Moderate	Moderate.
90–100	60–75	30–40	12–20	0.2–0.6	0.10–0.15	7.9–8.4	Moderate	Moderate.
85–95	25–45	<23	NP–5	2.0–6.0	0.10–0.15	7.9–8.4	Low	Moderate.
85–95	45–70	20–35	5–12	0.6–2.0	0.07–0.12	7.9–8.4	Low	Moderate.
85–95	51–75	25–40	8–15	0.6–2.0	0.12–0.16	7.9–8.4	Low	Moderate.
60–85	51–70	30–40	5–15	0.6–2.0	0.12–0.16	7.9–8.4	Low	Moderate.
20–60	13–49	30–40	5–15	0.6–2.0	0.01–0.04	7.9–8.4	Very low	Moderate.
95–100	70–90	35–50	15–30	0.2–0.6	0.14–0.18	6.6–8.4	Moderate	High.
95–100	80–95	45–60	25–35	<0.06	0.12–0.16	7.4–8.4	High	High.
90–100	80–95	35–50	20–30	0.06–0.2	0.12–0.16	7.9–8.4	Moderate	High.
96–100	70–98	41–65	20–40	<0.06	0.12–0.18	7.4–8.4	High	High.
90–100	60–93	25–45	8–25	0.6–2.0	0.15–0.20	7.9–8.4	Moderate	Moderate.
95–100	60–90	25–40	8–25	0.6–2.0	0.15–0.20	7.9–8.4	Moderate	Moderate.
85–95	36–70	20–35	5–20	0.6–2.0	0.14–0.18	7.9–8.4	Low	Moderate.
80–98	40–80	20–35	8–20	0.6–2.0	0.07–0.12	7.9–8.4	Low	Moderate.
85–95	25–49	<25	NP–5	2.0–6.0	0.10–0.15	7.9–8.4	Low	Moderate.
85–98	51–80	25–40	8–20	0.6–2.0	0.14–0.18	7.9–8.4	Low	Moderate.
80–98	40–80	20–35	8–20	0.6–2.0	0.07–0.12	7.9–8.4	Low	Moderate.
98–100	51–60	20–30	8–15	0.6–2.0	0.15–0.20	7.4–8.4	Low	Moderate.
95–99	60–70	30–42	12–22	0.6–2.0	0.15–0.20	7.9–8.4	Low	Moderate.
80–95	36–60	20–32	8–15	0.6–2.0	0.11–0.15	7.9–8.4	Low	Moderate.
75–85	51–70	30–40	12–20	0.6–2.0	0.12–0.16	7.9–8.4	Low	Moderate.

[2] Nonplastic.

TABLE 5.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of this table. Some terms that describe restrictive soil soils]

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Acuff: AcA	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Severe: low strength.
AcB, AcC	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Severe: low strength.
Amarillo: AmA	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
AmB, AmC	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
Arvana: ArA	Severe: cemented pan.	Severe: cemented pan.	Slight	Moderate: cemented pan.	Moderate: cemented pan.	Moderate: low strength; cemented pan.
Berda: BeC, BeD	Slight	Moderate: slope; seepage.	Moderate: slope; too clayey.	Slight	Slight	Moderate: low strength.
*Bippus: BfA, BpA	Slight	Moderate: seepage.	Moderate: cutbanks cave.	Moderate: low strength.	Moderate: too clayey.	Moderate: low strength.
BpB	Slight	Moderate: seepage.	Moderate: cutbanks cave.	Moderate: low strength.	Moderate: too clayey.	Moderate: low strength.
Bs. For Spur part, see Spur series.	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods
*Estacado: EsA	Slight	Moderate: seepage.	Moderate: too clayey.	Moderate: low strength.	Moderate: too clayey.	Severe: low strength.
EsB, EtC. For Posey part of EtC, see Posey series, PfB.	Slight	Moderate: seepage.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Severe: low strength.
Friona: FrA	Severe: cemented pan.	Severe: cemented pan.	Moderate: cemented pan.	Moderate: cemented pan; low strength.	Moderate: cemented pan.	Severe: low strength.
Kimbrough: KmC	Severe: cemented pan.	Severe: cemented pan.	Severe: cemented pan.	Severe: cemented pan.	Severe: cemented pan.	Severe: cemented pan.
Likes: LkD	Slight	Severe: seepage.	Severe: cutbanks cave.	Slight	Severe: too sandy; seepage.	Slight

interpretations

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate

Degree and kind of limitation for—Continued		Suitability as a source of—		Soil features affecting—		
Pond reservoir areas	Embankments, dikes, and levees	Road fill	Topsoil	Irrigation	Terraces and diversions	Waterways
Moderate: seepage.	Moderate: piping; seepage.	Poor: low strength.	Fair: too clayey.	Favorable	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; seepage.	Poor: low strength.	Fair: too clayey.	Slope	Favorable	Slope.
Moderate: seepage.	Moderate: piping; seepage.	Fair: low strength.	Fair: too clayey.	Favorable	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; seepage.	Fair: low strength.	Fair: too clayey.	Slope	Favorable	Slope.
Severe: cemented pan.	Moderate: thin layer.	Poor: thin layer.	Fair: thin layer.	Rooting depth	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; seepage.	Fair: low strength.	Fair: thin layer.	Slope	Favorable	Slope.
Moderate: seepage.	Moderate: piping; seepage; erodes easily.	Fair: low strength.	Fair: too clayey; thin layer.	Favorable	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; seepage; erodes easily.	Fair: low strength.	Fair: too clayey.	Slope	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; erodes easily.	Fair: low strength.	Fair: too clayey.	Floods	Floods	Floods.
Moderate: seepage.	Moderate: piping; erodes easily.	Poor: low strength.	Fair: too clayey.	Favorable	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; erodes easily.	Poor: low strength.	Fair: too clayey.	Slope	Favorable	Slope.
Severe: cemented pan.	Moderate: piping; thin layer; seepage.	Poor: low strength.	Fair: thin layer.	Rooting depth	Favorable	Favorable.
Severe: cemented pan.	Severe: thin layer.	Poor: thin layer.	Poor: thin layer.	Rooting depth	Not needed	Rooting depth.
Severe: seepage.	Moderate: piping; erodes easily.	Good	Poor: too sandy.	Droughty; erodes easily.	Not needed	Droughty; erodes easily.

TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Lipan: Lp	Severe: percs slowly.	Slight	Severe: too clayey.	Severe: shrink-swell.	Severe: too clayey.	Severe: shrink-swell.
Mobeetie: MoB	Slight	Severe: seepage.	Slight	Slight	Severe: seepage.	Moderate: low strength.
Olton:						
OtA	Moderate: percs slowly.	Slight	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: too clayey.	Moderate: low strength.
OtB	Moderate: percs slowly.	Slight	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: too clayey.	Moderate: low strength.
*Posey:						
PfA	Slight	Moderate: seepage.	Slight	Slight	Slight	Moderate: low strength.
PfB, PmD. For Berda part of PmD, see Berda series.	Slight	Moderate: slope; seepage.	Slight	Slight	Slight	Moderate: low strength.
Potter: PoE	Slight	Severe: seepage.	Severe: cemented pan.	Moderate: low strength.	Severe: cemented pan; seepage.	Moderate: low strength.
Pullman:						
PuA	Severe: percs slowly.	Slight	Severe: too clayey.	Severe: shrink-swell.	Severe: too clayey.	Severe: shrink-swell.
PuB	Severe: percs slowly.	Slight	Severe: too clayey.	Severe: shrink-swell.	Severe: too clayey.	Severe: shrink-swell.
Randall: Ra	Severe: floods; percs slowly.	Severe: floods.	Severe: floods; too clayey.	Severe: floods; shrink-swell.	Severe: floods; too clayey.	Severe: shrink-swell.
Spur: Mapped only in an undifferentiated group with Bippus soils.	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods
*Tulia:						
TuA	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Moderate: too clayey.	Severe: low strength.
TuB, TwC. For Potter part of TwC, see Potter series.	Slight	Moderate: slope; seepage.	Moderate: too clayey.	Slight	Moderate: too clayey.	Severe: low strength.
Zita: ZcA	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Moderate: too clayey.	Severe: low strength.

[1] Onsite study of the deep underlying strata, the water table, and the hazards of aquifer pollution and drainage into ground water need to be made for landfill more than 5 or 6 feet deep.

interpretations—Continued

Degree and kind of limitation for—Continued		Suitability as a source of—		Soil features affecting—		
Pond reservoir areas	Embankments, dikes, and levees	Road fill	Topsoil	Irrigation	Terraces and diversions	Waterways
Slight	Moderate: shrink-swell.	Poor: shrink-swell.	Poor: too clayey.	Slow intake	Not needed	Not needed.
Severe: seepage.	Moderate: piping; erodes easily.	Fair: low strength.	Good	Fast intake; slope.	Favorable	Erodes easily.
Moderate: seepage.	Moderate: piping.	Fair: low strength.	Fair: too clayey.	Favorable	Favorable	Favorable.
Moderate: seepage.	Moderate: piping.	Fair: low strength.	Fair: too clayey.	Slope	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; erodes easily.	Fair: low strength.	Fair: thin layer.	Favorable	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; erodes easily.	Fair: low strength.	Fair: thin layer.	Slope	Favorable	Slope.
Severe: cemented pan; seepage.	Severe: thin layer.	Fair: low strength.	Poor: thin layer.	Rooting depth; slope.	Slope	Rooting depth; slope.
Slight	Moderate: shrink-swell.	Poor: shrink-swell.	Fair: too clayey.	Slow intake	Favorable	Favorable.
Slight	Moderate: shrink-swell.	Poor: shrink-swell.	Fair: too clayey.	Slow intake; slope.	Favorable	Favorable.
Slight	Moderate: compressible; shrink-swell.	Poor: shrink-swell.	Poor: too clayey.	Slow intake; floods.	Not needed	Not needed.
Moderate: seepage.	Moderate: piping; erodes easily.	Fair: low strength.	Fair: thin layer.	Floods	Not needed	Not needed.
Moderate: seepage.	Moderate: piping; erodes easily.	Poor: low strength.	Fair: too clayey; excess lime.	Excess lime	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; erodes easily.	Poor: low strength.	Fair: too clayey; excess lime.	Excess lime; slope.	Favorable	Favorable.
Moderate: seepage.	Moderate: piping; erodes easily.	Poor: low strength.	Fair: too clayey.	Favorable	Favorable	Favorable.

different meanings in soil science than in engineering. Many of these terms commonly used in soil science are defined in the Glossary.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified soil classification system (*2*), used by the SCS engineers, Department of Defense, and others, and the AASHTO system adopted by the American Association of State Highway and Transportation Officials (*1*).

In the Unified soil classification system, soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML. The letters used in class designation mean; G, gravel, S, sand; M, silt; and C, clay. Clean sands are identified by SW or SP; sands that have fines of silt and clay by SM or SC; silt and clay that have a low liquid limit by ML and CL; and silt and clay that have a high liquid limit by MH and CH.

The AASHTO soil classification system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet, the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated AASHTO classification, without group index numbers, is given in table 4 for all soils mapped in the survey area.

Estimated properties

Several estimated soil properties significant to engineering are given in table 4. These estimates are made for typical soil profiles by layers sufficiently different to behave in a different way when used for engineering purposes. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and one experience with the same kinds of soil in other counties. In the following paragraphs the columns in table 4 are explained.

Hydrologic group gives the runoff potential from rainfall. Four major soil groups are used, and the soils are classified on the basis of intake of water at the end of long-duration storms that occur after prior wetting and opportunity for swelling and without the protective effects of vegetation.

The major soil groups are—

Group A consists of soils that have a high infiltration rate even when thoroughly wetted. They are chiefly deep, well-drained to excessively drained sand or gravel, or both. These soils have a high rate of water transmission and a low runoff potential.

Group B consists of soils that have a moderate infiltration rate when thoroughly wetted. They are chiefly moderately deep to deep, moderately well drained to well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission and a moderate runoff potential.

Group C consists of soils that have a slow infiltration rate when thoroughly wetted. They are chiefly soils that have a layer that impedes downward movement of water or soils that have moderately fine texture to fine texture. These soils have a slow rate of water transmission and a high runoff potential.

Group D consists of soils that have a very slow infiltration rate when thoroughly wetted. They are chiefly clay soils that have a high swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission and a very high runoff potential.

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer. A column was not included in the table, because none of the soils in Parmer County have bedrock at the depth investigated except the following soils, which have indurated caliche at the depths indicated: Arvana soils, 20 to 36 inches; Friona soils, 22 to 36 inches; Kimbrough soils, 5 to 13 inches; and Potter soils, 5 to 12 inches.

Depth from surface gives the depth in inches for the major distinctive layers of the soil profile.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years. This column was not included in the table, because none of the soils in Parmer County have a high water table.

Soil texture is described in table 4 in the standard terms used by the U.S. Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loamy sand." "Sand," "silt," "clay," and other terms used in USDA textural classification are defined in the Glossary.

The percentage passing sieve estimates are given for a range in percentage of soil material passing sieves of four sizes. This information is useful in helping to determine suitability of the soil as a material for construction purposes.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture con-

tent at which the soil material changes from the semisolid to plastic state, and the liquid limit from a plastic to a liquid state. The plasticity index is the numerical difference betwen the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 4.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 4 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts. These ratings should not be confused with the coefficient of permeability, or *k*-value, used by engineers.

Available water capacity is the ability of a soil to hold water for use by most plants. It commonly is defined as the numerical difference between the amount of water in the soil at field capacity and the amount of water at the time most crop plants wilt. The rate is expressed as inches of water per inch of soil depth.

Reaction is the degree of acidity or alkalinity of a soil expressed as pH. The pH value and terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to metals and concrete. Salinity is no problem in soils of Parmer County, and this column was not included in table 4.

Shrink-swell potential is the relative change in volume to be expected of the soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to the maintenance of structures built in, on, or of material having this rating.

Corrosivity, as used in table 4, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to soil properties such as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate as well as by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that the probability of soil-induced corrosion damage is low. A rating of *high* means that the probability of damage is high, so that protective measures for steel and a more resistant type of concrete should be used to avoid or minimize damage. Corrosivity to concrete rates low for all soils in Parmer County; therefore, only corrosivity to uncoated steel is rated in table 4.

Subsidence is settlement of organic soils or of soils containing semifluid mineral layers. Ratings for subsidence take into account (1) rapid initial loss of elevation resulting from drainage and lowering of the level of the ground water and (2) later and slower loss of elevation that results from oxidation of organic materials. The maximum possible loss of surface elevation is called *potential subsidence.* A column for subsidence was not included in the table, because subsidence is no problem in soils of the county.

Engineering interpretations

The estimated interpretations in table 5 are based on the engineering properties of soils shown in table 4. In table 5, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for irrigation, waterways, and terraces and diversions. For these particular uses, table 5 lists those soil features not to be overlooked in planning, installing, and maintaining structures.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance. For some uses the rating of severe is divided to obtain ratings of severe and very severe.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

In the following paragraphs the columns in table 5 are explained.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between the depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects the difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumptions are made that the embankment is compacted to medium density and that the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic-matter content, and slope; if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified soil classification system, and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, such as excavations for pipelines, sewerlines, phone and power

transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or from a high water table.

Dwellings without basements, as rated in table 5, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 5 apply only to a depth of about 6 feet; therefore, limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. Even though reliable predictions can be made to a depth of 10 to 15 feet for some soils, every site should be investigated before it is selected.

Local roads and streets, as rated in table 5, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly of asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep. Soil properties that most affect design and construction of roads and streets are load-supporting capacity, stability of the subgrade, and workability and quantity of cut and fill material available. The AASHTO and Unified classifications of the soil material as well as the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect the ease of excavation and the amount of cut and fill needed to reach and even grade.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and their depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage and piping and has favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are unfavorable factors.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of a soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. A column was not included in the table, however, because the soils of Parmer County are not good sources of sand and gravel.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants grown on the soil when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability. Damage that results at the area from which topsoil is taken is also considered in the rating. Excess lime refers to calcium carbonate equivalent of a soil. The percentage of calcium carbonate equivalent is given in the range of characteristics of those soils where this characteristic is important. A calcium carbonate equivalent greater than 15 percent will cause chlorosis in many plants. The chlorosis can be helped with the application of iron supplements and large amounts of organic residues. A calcium carbonate equivalent that exceeds 30 percent is impractical to correct for use as topsoil.

Drainage of cropland and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope, stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage. A column was not included in the table since this is not a problem in soils of the county.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Waterways are either natural or shaped channels seeded with grass to carry runoff without causing erosion. The suitability of a soil for grassed waterways is determined by the erosion hazard and the amount of shaping that can be done. This depends upon such features as slope, stoniness, and depth to bedrock. The ease of establishing vegetation in the waterway is also an important soil feature.

Recreational Development

Knowledge of soils is necessary for planning, developing, and maintaining areas used for recreation. In table 6 the soils of Parmer County are rated according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails.

The soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, by design, or by special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these activities is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required, other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used primarily for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increase cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rains but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or on horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded not more than once during the season of use, have a slope of less than 15 percent, and have few or no rocks or stones on the surface.

Formation and Classification of the Soils

This section describes the major factors of soil formation and tells how these factors have affected the soils of Parmer County. It also defines the current system for classifying soils and shows the classification of the soil series and higher categories.

Factors of Soil Formation

Soil is produced by the action of soil-forming factors on material deposited or accumulated by natural forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material.

Climate and living organisms, particularly vegetation, are the active forces in soil formation. These forces act on the parent material that has accumulated through the weathering of rocks and unconsolidated deposits and slowly change that material into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed to change the parent material into a soil. The amount of time may be short or long, but some time is always required for soil horizons to form. Usually, a long time is required for distinct horizons to develop in a soil.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown. The following paragraphs briefly describe the parent material, the climate, the plant and animal life, and the relief of Parmer County and tell how time has affected the formation of the soils.

Parent material

Parent material has probably had more influence than any other factor on the kinds of soil that have formed in this county (*3,4*). The soils formed in the geologic formation of the High Plains deposits.

High Plains deposits have two main parts. The lower part is the Ogallala Formation, and the upper part is a mantle of loess. The Ogallala Formation is calcareous outwash made up of sand, gravel, and caliche. It is exposed along some of the draws. Potter soils formed in exposed material from this formation.

The upper part of the High Plains deposits is 30 to 100 feet thick and consists of a mantle that blankets much of the county. Most of the soils in the county formed in this formation. This mantle consists of alternating layers of clay loam, sandy clay loam, and loam interbedded with layers of soft, pinkish-white caliche. The kind of soil that formed at any given place on the High Plains appears to depend mainly on the kind of parent material at the surface at that particular place. Pullman soils, for example, formed in material from finer textured layers, which accounts for the clayey, dense lower layers of these soils. Estacado, Posey, and Tulia soils are calcareous because they formed in limy material from the layers of loamy caliche. Acuff and Olton soils formed in the layers of clay loam or sandy clay loam.

Several soils formed in reworked sediment from the mantle. Among these are Berda, Bippus, Likes, Lipan,

TABLE 6.—*Degree of limitation and soil properties affecting recreational development*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table. Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Acuff:				
AcA, AcB	Slight	Slight	Slight	Slight.
AcC	Slight	Slight	Moderate: slope	Slight.
Amarillo:				
AmA, AmB	Slight	Slight	Slight	Slight.
AmC	Slight	Slight	Moderate: slope	Slight.
Arvana: ArA	Slight	Slight	Slight	Slight.
Berda:				
BeC	Slight	Slight	Moderate: slope	Slight.
BeD	Slight	Slight	Severe: slope	Slight.
*Bippus:				
BfA	Slight	Slight	Slight	Slight.
BpA, BpB	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
Bs	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
For Spur part, see Spur series.				
*Estacado: EsA, EsB, EtC	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
For Posey part of EtC, see Posey series, PmD.				
Friona: FrA	Slight	Slight	Slight	Slight.
Kimbrough: KmC	Slight	Slight	Severe: depth to rock.	Slight.
Likes: LkD	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy; slopes.	Moderate: too sandy.
Lipan: Lp	Severe: percs slowly; too clayey.	Severe: too clayey	Severe: percs slowly; too clayey.	Severe: too clayey.
Mobeetie: MoB	Slight	Slight	Slight	Slight.
Olton: Ota, OtB	Moderate: percs slowly.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
*Posey:				
PfA, PfB	Slight	Slight	Slight	Slight.
PmD	Slight	Slight	Severe: slope	Slight.
For Berda part, see Berda series, BeD.				
Potter: PoE	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Pullman: PuA, PuB	Moderate: percs slowly.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
Randall: Ra	Severe: floods	Severe: floods	Severe: floods	Severe: too clayey.
Spur: Mapped only in an undifferentiated group with Bippus series.	Severe: floods	Moderate: floods	Severe: floods	Slight.
*Tulia:				
TuA, TuB	Slight	Slight	Slight	Slight.
TwC	Slight	Slight	Moderate: slope	Slight.
For Potter part, see Potter series.				
Zita: ZcA	Slight	Slight	Slight	Slight.

and Randall soils. Randall soils formed in beds of clay settlings in playa basins. Likes soils formed in windblown material that has lime and that washed from Ogallala Sand and then was blown into place during windy, dry periods. Berda soils formed in calcareous colluvium that has settled on slopes along draws that are below escarpments.

Climate

The climate of Parmer County is uniform, but its effects have been modified locally by relief and runoff. Randall soils are clays that formed in playas. Because rainfall is low and there are long, dry periods, soil development is slow. Except in irrigated areas, the soils are seldom wet below the root zone, and as a result, many have a horizon of calcium carbonate accumulation. Leaching has not removed free lime from the upper layers of Berda, Estacado, Kimbrough, Likes, Lipan, Posey, Potter, and Tulia soils.

Climate has affected the formation of some of the soils through the action of strong winds. The Likes soils formed from strongly calcareous, sandy, windblown sediments. These sediments were washed and then blown into their present position by westerly winds. More climatic data are given in the section "General Nature of the County."

Plant and animal life

Plants, earthworms, micro-organisms, and other forms of animal life that live on and in the soil contribute to soil development. The kinds of organisms are determined mainly by climate and parent material.

In Parmer County, climate has limited the kind of vegetation mainly to grasses. The kind of parent material in which the soils formed determined whether the grasses would be tall, as on the sandy soils, or short, as on the loamy soils. Grasses growing throughout much of the county contribute organic matter to the soils. When the leaves and stems decay, they add organic matter to the surface layer. When the roots die and decompose, they help to build up a supply of plant nutrients in the rest of the solum. The network of pores and tubes left by decaying roots hastens the passage of air and water through the soils.

Earthworms are the most obvious form of animal life in most of the soils. Worm casts add to the fertility of the soils and to the movement of air, water, and plant roots through the soil profile. In some soils in the county, rodents, such as prairie dogs, influenced the development of soils. By their burrowing, the animals mix the soil material. This mixing tends to offset the effects of the leaching of carbonates and the downward movement of clay. Nests, or krotovinas, made by rodents in Pullman soils range from 4 to 18 inches in diameter (fig. 23). They are filled with grayish-brown silty material that is high in organic-matter content. Bison, pronghorn antelope, rabbit, and other animals also affected the formation of soils by grazing, trampling, bedding, and manuring.

Man also has influenced soil formation by fencing the range and allowing it to be overgrazed, changing the vegetation, and clearing and plowing the soils for crops. He has clean harvested the crops and has not controlled runoff and soil blowing. Because of these practices, organic matter has been depleted and silt and clay particles have been blown from the plow layer. Use of heavy machinery and untimely tillage have compacted the soils and, thus, have slowed the infiltration of water and air. Irrigation has drastically changed the natural moisture regime in some areas.

Relief

Relief influences the formation of soils mostly through its effect on drainage and runoff. If other factors of soil formation are equal, the degree of profile development depends mainly on the average amount of moisture that enters and passes through the soil. Steep soils absorb less moisture than less sloping ones, and they are more susceptible to erosion. Therefore, they generally have a thinner, less developed profile.

Some soils in the county, such as Acuff, Olton, and Pullman soils, are nearly level or gently sloping. Most of the moisture from rainfall has penetrated those soils; therefore, relief has not been a limiting factor in the development of a soil profile.

In contrast, Potter soils have been strongly influenced by relief. Because these soils are gently sloping to sloping, runoff is rapid and geologic erosion is active. Rainfall penetrates to only a limited depth; therefore, the vegetation is sparse. Vegetation, time, and climate can produce and sustain only a very shallow to shallow soil. To a lesser extent than in Potter soils, relief has affected the formation of a profile in Berda and Posey soils because runoff is constantly wearing away the upper part of the soil profile as fast as it is formed.

Randall soils are also affected to some extent by relief. They are somewhat poorly drained and are covered by water for long periods. Consequently, some of the minerals in those soils, especially iron and manganese, have been changed and the kinds and amounts of clay probably have been affected.

Time

Time is required for a soil to form. The time required depends on parent material, climate, plant and animal life, and relief. A mature soil is considered to be stable in its environment. It changes little as time passes, because the environmental factors have already exerted their influence on the parent material. These factors are making their impression on the soil profile, but more time is needed for a mature soil to form. Thus, the age of a soil is determined by the degree to which the parent material has been changed toward the full development of a soil profile that has its own unique set of characteristics.

Acuff, Amarillo, Olton, and Pullman soils have been in place long enough to have developed a mature profile. They are deep and have pronounced horizon development. Free lime has been leached into the lower horizons, and much of the clay has moved out of the surface layer and into the subsoil. The A and B horizons of these soils are distinct.

Likes soils, on the other hand, are young and immature. They have been in place such a short time that horizons have hardly begun to form. There has been a slight movement of lime into the subsoil, and the surface layer has been darkened somewhat by vegetation. Berda soils are also immature. Although considerable amounts of lime have moved out of their solum, these

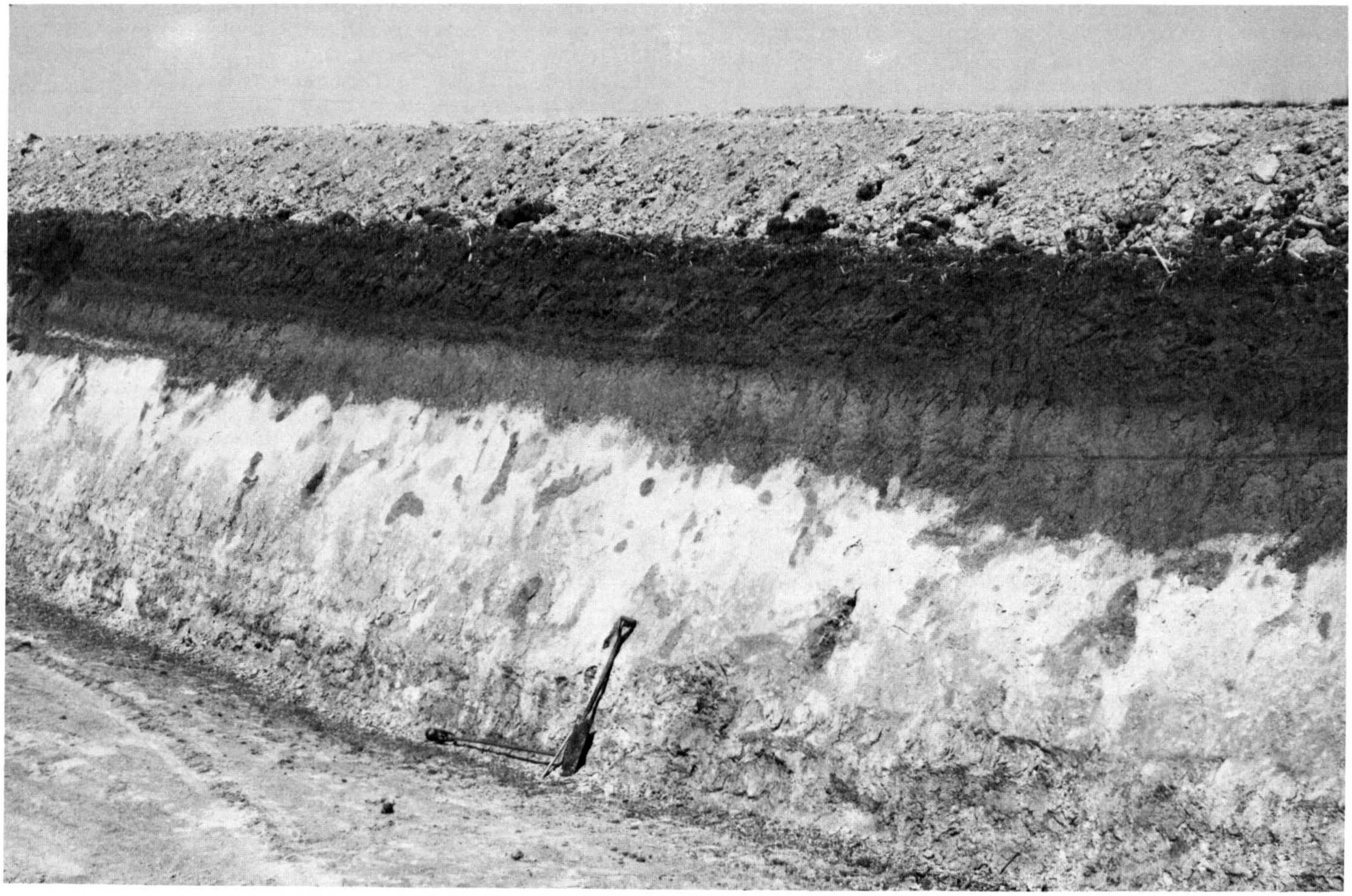

Figure 23.—**Profile of Pullman clay loam, 0 to 1 percent slopes, showing wavy boundary of Btca horizon and dark, irregularly shaped nests, or krotovinas.**

soils do not show the full effects of their environment. They have weakly expressed horizons.

Because Randall soils are clayey, time probably has had little influence on their development. Parent material and relief have been the dominant factors in their formation. The profile of those soils will probably not change much in the future unless some change takes place in the environment.

Irrigation probably has affected soil formation through changes that it brings about in the climatic factor. At present, though the supplies of plant nutrients and organic matter in the soils have been altered by irrigation, no horizon changes in the soil profiles, as a result of irrigation, can be seen.

The oldest soils in the county are the buried soils that formed in the mantle on the High Plains. The mantle appears to have been deposited during different periods. After one deposition, soils formed at the surface for an extended period and were then covered when the next layer of material was deposited.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should search the latest literature available (*5, 7*).[5]

The current system of classification has six categories. Beginning with the broadest, these categories

[5] See the unpublished working document "Selected Chapters from the Unedited Text of the Soil Taxonomy" available in the SCS State Office, Temple, Texas.

are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 7, the soil series of Parmer County are placed in four categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

The six orders to which the soils of Parmer County belong are Alfisols, Aridisols, Entisols, Inceptisols, Mollisols, and Vertisols.

Alfisols have a light-colored surface layer that is low in organic matter, a clay-enriched B horizon, an accumulation of aluminum and iron, and a base saturation of more than 35 percent.

Aridisols have a light-colored surface layer that is low in organic matter, and they have inadequate moisture to mature a crop without irrigation in most years.

Entisols have little or no evidence of development of pedogenic horizons.

Inceptisols have a light-colored surface layer that is low in organic matter, but they lack a clay-enriched B horizon.

Mollisols have a dark-colored surface layer that is high in organic matter, and they have a base saturation of more than 50 percent.

Vertisols are clayey soils that have deep, wide cracks during a part of each year in most years.

SUBORDER: Each order is divided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or the absence of waterlogging or soil differences that result from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquent* (*Aqu*, meaning water or wet, and *ent*, from Entisol).

GREAT GROUP: Each suborder is separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have

TABLE 7.—*Soil series classified according to the current system of classification*[1]

Series	Family	Subgroup	Order
Acuff	Fine-loamy, mixed, thermic	Aridic Paleustolls	Mollisols.
Amarillo	Fine-loamy, mixed, thermic	Aridic Paleustalfs	Alfisols.
Arvana	Fine-loamy, mixed, thermic	Petrocalcic Paleustalfs	Alfisols.
Berda	Fine-loamy, mixed, thermic	Aridic Ustochrepts	Inceptisols.
Bippus	Fine-loamy, mixed, thermic	Cumulic Haplustolls	Mollisols.
Estacado	Fine-loamy, mixed, thermic	Calciorthidic Paleustolls	Mollisols.
Friona	Fine-loamy, mixed, thermic	Petrocalcic Paleustolls	Mollisols.
Kimbrough	Loamy, mixed, thermic, shallow	Petrocalcic Calciustolls	Mollisols.
Likes	Mixed, thermic	Typic Ustipsamments	Entisols.
Lipan	Fine, montmorillonitic, thermic	Entic Pellusterts	Vertisols.
Mobeetie	Coarse-loamy, mixed, thermic	Aridic Ustochrepts	Inceptisols.
Olton	Fine, mixed, thermic	Aridic Paleustolls	Mollisols.
Posey	Fine-loamy, mixed, thermic	Calciorthidic Paleustalfs	Alfisols.
Potter	Loamy, carbonatic, thermic, shallow	Ustollic Calciorthids	Aridisols.
Pullman	Fine, mixed, thermic	Torrertic Paleustolls	Mollisols.
Randall	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols.
Spur	Fine-loamy, mixed, thermic	Fluventic Haplustolls	Mollisols.
Tulia	Fine-loamy, carbonatic, thermic	Calciorthidic Paleustalfs	Alfisols.
Zita	Fine-loamy, mixed, thermic	Aridic Haplustolls	Mollisols.

[1] As of August, 1972.

pans that interfere with growth of roots, movement of water, or both; and those that have thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquents (*Hapl*, meaning simple horizons, *aqu* for wetness or water, and *ent*, from Entisols).

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and others called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties intergrade outside the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquents(a typical Haplaquent).

FAMILY: Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiae. An example is the coarse-loamy, siliceous, acid, thermic family of Typic Haplaquents.

SERIES: The series consists of a group of soils that have major horizons that, except for texture of the surface layer, are similar in important characteristics and in arrangement in the profile.

General Nature of the County

This section provides information for those not familiar with the county. It describes the climate and geology, discusses the history and settlement, and gives facts about transportation and markets.

Climate[6]

Parmer County is in a cool-temperate climatic zone. It has a dry, steppe, continental climate characterized by mild winters and by large variations in annual extremes of temperature. Facts about temperature and precipitation are given in table 8.

Rainfall averages 17.50 inches annually, based on long-term records in surrounding counties. Amounts vary considerably from month to month and from year to year. More than 80 percent of the average total precipitation falls during the 7-month period of April through October. Warm-season rainfall occurs most frequently as a result of thundershowers. Monthly rainfall totals decrease significantly during the cold season as frequent cold fronts accompanied by strong northerly winds cut off the supply of moisture from the Gulf of Mexico. The area is subjected to prolonged and severe periods of drought. The most notable of these were the periods from April 1933 through August 1936 and from August 1951 through February 1957, which lasted for 41 months and 67 months, respectively.

Prevailing winds are southerly to southwesterly throughout the year, but northerly winds are frequent in the colder months. Occasionally, strong winds, usually from the southwest through the north, cause blowing dust. The strongest sustained winds are in March and April and are associated with intense low-pressure centers.

Temperature, like rainfall, is extremely variable, especially during the colder months of the year, November through April. Cold fronts from the northern Great Plains sweep across the Panhandle plains at 25 to 35 miles per hour. Temperature drops of 50° to 60°F in a 12–hour period have occurred. Despite occasional low temperatures, winters in Parmer County are mild compared to those of the northern Great Plains. Cold spells rarely last for more than 2 or 3 days before southwesterly winds from the high New Mexican plateaus cause rapid warming.

The dry air, high elevation, and usually clear skies are ideal conditions for insolation; consequently, there is a large daily range between maximum and minimum temperatures. Midafternoon temperatures are high in summer, but they drop rapidly after sundown. Average daily minimum temperatures during midsummer are in the middle sixties. Parmer County receives about 74 percent of the total possible sunshine annually. Seasonally, this varies from about 0 percent in winter to 78 percent in summer.

Average annual snowfall is estimated at 7.2 inches, based on long-term records in neighboring counties. Snowfall amounts vary greatly from year to year. A few exceptionally heavy snows bias these data and render the average total a poor estimate of expected snowfall. Strong winds almost always cause heavy drifting and an uneven cover.

The average length of the warm season (freeze-free period) in Parmer County is 183 days. The average date of the last occurrence of 32° or below in spring is April 20, and the first occurrence of 32° or below in fall is October 20. Average relative humidity at noon is estimated at 45 percent in January, 35 percent in April, 43 percent in July, and 39 percent in October.

Geology

The origin of the High Plains is important in the geologic history of Parmer County (*4*). During the Permian Period a large area that included nearly all of the present Panhandle of Texas, the eastern part of New Mexico, and the western part of Oklahoma was under a shallow sea. Sediment deposited in this sea formed what is known as the Permian red beds. Later, as a result of movements inside the earth, this area rose above the level of the sea. Streams began to form on the exposed rocks of the red beds. Material was washed from the higher places and redeposited along the channels of streams. Nearly all of the surface ma-

[6] By ROBERT B. ORTON, climatologist for Texas, National Weather Service, U.S. Department of Commerce.

terial of Permian age in Parmer County was reworked in this way, and the resulting sediment is known as the Triassic red beds. The Santa Rosa Sandstone Formation is a part of the Triassic red beds. This formation is a source of some irrigation water that has harmful salts in it.

The uplift of the Rocky Mountains during the Pliocene Epoch was the next important geologic event. Swift streams, flowing from the mountains to the west, cut valleys and canyons through the red beds of Triassic age, and in some places, into the red beds of Permian age. When the mountains reached their maximum height, they began to erode more rapidly. At that time, the climate was extremely wet and rains carried coarse, gravelly material down the slopes and eastward out onto the plains. This material made up the first deposits of the Ogallala Formation and represents the present water-bearing material.

Finer textured sand and calcareous, loamy soil material were washed down after the coarse, gravelly material and formed alluvial fans and outwash aprons over the Triassic red beds until the entire surface was finally covered. These deposits gradually built up to form a vast plain, the Ogallala Formation, which extended several hundred miles to the east of the Rockies. The Ogallala Formation in this county ranges from 100 to 600 feet in thickness. Potter soils formed in these deposits.

The next important geologic event was the deposition of a mantle of loess on the surface of the Ogallala Formation (*4*) during about the middle of the Pleistocene Epoch. The climate by this time had reversed itself and had again become dry, windy, and desiccating. During this period, the Pecos River and other rivers were forming to the west and south. The dry climate and the prevailing southwesterly winds caused fine-textured sediments to be blown from river bottoms and to be carried to the northeast. These sediments settled on the Ogallala outwash plain to form a loess mantle that built up until it is now between 30 and 100 feet thick. Most of the soils of the High Plains, which include the Acuff, Olton, and Pullman soils, formed in this mantle.

The most recent geologic formations in the county are the extensive alluvial deposits along streams. They are probably of late Wisconsin or Recent geologic age.

The source of the underground water used for nearly all irrigation is the saturated sand and gravel at the base of the Ogallala Formation. This water probably accumulated during the wet, humid period when the formation was being deposited. The underlying, impervious red beds kept the water from percolating to a greater depth. When the Ogallala Formation was cut off from the Rocky Mountains by the Pecos River, its source of recharge water was lost. At present, there seems to be little or no recharge from rainfall, and water is pumped out faster than it is restored. Representatives of the High Plains Underground Water District are making a study of the decline of the water table by observing selected wells.

The distinguishing features of the High Plains are the exceedingly level upland surface and the higher areas separated from the lower basins by long, low slopes. The basins contain playas of Randall clay. Drainage is poor, and most lakes have no surface outlets.

History and Settlement

The area that is now Parmer County was originally the hunting grounds of Comanches, Kiowas, Apaches, and other Indians who hunted bison, deer, and antelope. Prairie dog towns spread for miles over the short grassland.

Parmer County was created from the Bexar County Territory in 1876. The county remained under Jack, Oldham, and Wheeler County governments until it was organized in 1907. Parmer County was part of the 3,050,000-acre XIT ranch. It was one of the 10 counties that made up the Capitol Syndicate Land Grant, which built the present Texas State Capitol. The XIT now owns only mineral rights in Parmer County. The last of the land was sold about 1956.

In 1898 the Pecos Valley Railway, which was later absorbed by the Santa Fe Railroad, was built from Clovis, New Mexico to Amarillo, Texas. Several towns gradually grew up after the railroad was built. The population increased to more than 1,000 by 1910. Before and during the early settlement and until after the turn of the century, the county experienced several large prairie fires, droughts, and invasions by hordes of grasshoppers.

During the first half of the 20th century, Parmer County was transformed from a native grass area to one of ranches and dryland farms. The drought in the early 1930's struck the Great Plains. The resulting duststorms, lack of rainfall, and low market prices forced many farmers to leave the area. Since the beginning of the mid-1940's, the county has turned almost completely into an irrigated area. At present about 3,435 irrigation wells furnish water to about 410,000 acres. The majority of the irrigated areas and about 64,000 dryfarmed acres are used for grain sorghum, wheat, corn, and cotton. Sudan, barley, sorghum, vegetables, sesame, castor beans, and hay and seed crops are also grown. Cattle and swine feeding has been on the increase. There has also been a rapid increase in the use of commercial fertilizers.

Transportation and Markets

The transportation needed for marketing vegetables, cattle, and grain crops is provided by truck and by the Atchison, Topeka and Santa Fe railroad. The railroad runs from the northeast through Friona and Bovina to Farwell. Another rail line runs southeast of Farwell. U.S. Highways 60, 70, 84 and several Texas Highways and farm-to-market roads furnish outlets to markets. Nearly all farms in Parmer County are less than 4 miles from a paved road.

Bovina, Farwell, and Friona are the banking and commercial centers of the county. Several large grain elevators are located in the county, as well as a number of cotton gins. A beef slaughtering plant, which slaughters cattle from local feedlots, is located in the county. Vegetables are processed locally and trucked to distant markets. Wheat is sold mostly to local elevators, which transport it to distant markets. Most of the grain sorghum and corn is used in local feedlots. The baled hay and silage are fed locally.

TABLE 8.—*Temperature*

[Data recorded at Friona;

Month	Temperature [1]				Precipitation [2]		
	Average daily maximum	Average monthly maximum	Average daily minimum	Average monthly minimum	Average total	Probability of receiving— 0 or trace	Probability of receiving— 0.50 inch or more
	°F	°F	°F	°F	In	Pct	Pct
January	52.5	71.9	21.2	1.0	0.61	3	43
February	53.1	71.9	24.1	9.5	.45	7	32
March	60.3	79.8	30.0	14.0	.56	10	42
April	72.5	86.5	41.4	29.4	1.10	(3)	64
May	80.3	94.5	50.3	36.1	2.80	(3)	92
June	86.3	99.0	58.7	47.9	2.38	1	90
July	91.8	99.1	64.5	57.6	2.55	(3)	90
August	88.6	98.1	61.9	55.8	2.20	(3)	90
September	81.7	93.8	54.7	42.4	1.85	3	79
October	73.4	89.0	42.0	30.4	1.85	4	70
November	62.1	78.8	32.5	19.3	.52	22	40
December	52.9	72.6	23.6	8.1	.63	10	40
Year	71.3	----------	42.1	----------	17.50	----------	----------

[1] For the period 1963–70.

[2] Estimated from long term records at surrounding stations.

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Glossary

ABC soil. A soil that has a complete profile, including an A, B, and C horizon.

AC soil. A soil that has an A and a C horizon but no B horizon. Commonly such soils are immature, as those developing from alluvium or those on steep, rocky slopes.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Blowout. An excavation produced by wind action in loose soil, usually sand.

Bench terrace. A shelflike embankment of earth that has a level or nearly level top and a steep or nearly vertical downhill face, constructed along the contour of sloping land or across the slope to control runoff and erosion. The downhill face of the bench may be made of rocks or masonry, or it may be planted to vegetation.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers

and precipitation

elevation 4,010 feet]

Precipitation [3]—Contd.									
Probability of receiving—Contd.						Average number of days with precipitation of—			Snow and sleet
1 inch or more	2 inches or more	3 inches or more	4 inches or more	5 inches or more	6 inches or more	0.10 inch or more	0.50 inch or more	1 inch or more	Average total
Pct	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*				*Inches*
22	5	1	(3)	(3)	(3)	1	(4)	0	1.4
12	2	(3)	(3)	(3)	(3)	2	(4)	(4)	2.9
24	7	2	(3)	(3)	(3)	2	(4)	(4)	.1
40	16	6	2	(3)	(3)	2	1	(4)	.4
80	54	35	25	15	9	3	1	(4)	0
72	52	30	15	9	7	6	3	1	0
73	45	25	14	7	4	5	2	1	0
74	45	26	13	8	5	4	1	1	0
61	33	20	10	5	4	3	1	(4)	0
70	29	18	8	4	3	2	1	(4)	.1
17	4	(3)	(3)	(3)	(3)	2	(4)	(4)	.7
20	5	1	(3)	(3)	(3)	1	(4)	(4)	1.6
----------	----------	----------	----------	----------	----------	33	10	3	7.2

[3] Less than 1 percent.

[4] Less than one-half day.

in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Cemented pan. Cemented pan too close to surface.

Chiseling. Tillage of soil with an implement having one or more soil penetrating points that loosen the subsoil and bring *clods* to the surface. A form of emergency tillage to control soil blowing.

Chlorosis. A yellowing between veins on upper foliage that results from chlorophyll deficiency. Many factors, including heredity, cause chlorosis.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Cutbanks cave. Walls of cuts not stable.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Deferred grazing. The practice of delaying grazing until range plants have reached a definite stage of growth, in order to increase the vigor of the forage and to allow the desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gilgai. Typically, the microrelief of Vertisols—clayey soils that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to relatively level plots surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops, or in orchards, to confine the flow of water to one direction.

Furrow.—Water is applied in small ditches made by cultivation implements used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Irrigation water, released at high points, flows onto the field without controlled distribution.

Leaching, soil. The removal of soluble material from soils or other material by percolating water.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Low strength. Inadequate strength to support the load.

Moh's scale. A scale of hardness introduced by F. Mohs and expressed in terms as follows: (1) talc; (2) gypsum; (3) calcite; (4) fluorite; (5) apatite; (6) orthoclase; (7) quartz; (8) topaz; (9) sapphire; and (10) diamond.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Outwash material. A mantle of soil material, a few feet to 60 feet thick or more, washed from the High Plains and Rocky Mountains by streams of melt water and deposited on the Permian Red Beds during glacial times.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Percs slowly. Water moves through the soil too slowly.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Piping. Water can form tunnels or pipelike cavities in the soil.

Playa. A flat-bottomed, undrained basin or lakebed that contains water for varying periods following rains.

Plowpan. A compacted layer formed in the soil immediately below the plowed layer.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, ex-

pressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth. Soil thin over layer that restricts roots.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Seepage. Water moves through soil too fast.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Shrink-swell. Soil expands significantly when wet and shrinks when dry.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles, less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangements of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Type, soil. A subdivision of the soil series that is made on the basis of differences in the texture of the surface layer.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an oven-dry basis, at which plants (specifically sunflower) wilt so much that they do not recover when placed in a dark, humid atmosphere.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, wildlife rating, or recreational development, read the introduction to the section it is in for general information about its management. Dashes in a column mean that the mapping unit was not placed in that particular grouping.

			Capability unit		Range site	
			Dryland	Irrigated		
Map symbol	Mapping unit	Page	Symbol	Symbol	Name	Page
AcA	Acuff loam, 0 to 1 percent slopes	7	IIIe-4	IIe-1	Clay Loam	35
AcB	Acuff loam, 1 to 3 percent slopes	7	IIIe-2	IIIe-2	Clay Loam	35
AcC	Acuff loam, 3 to 5 percent slopes	8	IVe-1	IIIe-5	Clay Loam	35
AmA	Amarillo fine sandy loam, 0 to 1 percent slopes	8	IIIe-3	IIe-2	Sandy Loam	37
AmB	Amarillo fine sandy loam, 1 to 3 percent slopes	9	IIIe-3	IIIe-3	Sandy Loam	37
AmC	Amarillo fine sandy loam, 3 to 5 percent slopes	9	IVe-3	IVe-1	Sandy Loam	37
ArA	Arvana fine sandy loam, 0 to 1 percent slopes	11	IIIe-3	IIe-2	Sandy Loam	37
BeC	Berda loam, 3 to 5 percent slopes	12	IVe-3	IVe-2	Hardland Slopes	36
BeD	Berda loam, 5 to 8 percent slopes	12	VIe-2	------	Hardland Slopes	36
BfA	Bippus fine sandy loam, 0 to 1 percent slopes	14	IIIe-3	IIe-2	Valley	37
BpA	Bippus clay loam, 0 to 1 percent slopes	14	IIe-1	IIe-1	Valley	37
BpB	Bippus clay loam, 1 to 3 percent slopes	14	IIIe-2	IIIe-2	Valley	37
Bs	Bippus and Spur soils, frequently flooded	14	Vw-1	------	Valley	37
EsA	Estacado clay loam, 0 to 1 percent slopes	16	IIIe-6	IIe-1	Hardland Slopes	36
EsB	Estacado clay loam, 1 to 3 percent slopes	16	IIIe-2	IIIe-2	Hardland Slopes	36
EtC	Estacado-Posey complex, 3 to 5 percent slopes	16	IVe-4	IVe-2	Hardland Slopes	36
FrA	Friona loam, 0 to 1 percent slopes	18	IIIe-6	IIe-1	Clay Loam	35
KmC	Kimbrough loam, 1 to 5 percent slopes	19	VIIs-1	------	Very Shallow	38
LkD	Likes loamy fine sand, 1 to 8 percent slopes	20	VIe-1	------	Sandy	36
Lp	Lipan clay, depressional	21	IVw-1	IVs-1	Lakebed	36
MoB	Mobeetie fine sandy loam, 0 to 3 percent slopes	21	IIIe-3	IIIe-3	Mixedland Slopes	36
OtA	Olton clay loam, 0 to 1 percent slopes	23	IIIe-6	IIe-1	Clay Loam	35
OtB	Olton clay loam, 1 to 3 percent slopes	23	IIIe-2	IIIe-2	Clay Loam	35
PfA	Posey fine sandy loam, 0 to 1 percent slopes	24	IIIe-3	IIIe-4	Mixedland Slopes	36
PfB	Posey fine sandy loam, 1 to 3 percent slopes	24	IIIe-3	IIIe-4	Mixedland Slopes	36
PmD	Posey-Berda complex, 5 to 8 percent slopes	25	VIe-2	------	Hardland Slopes	36
PoE	Potter loam, 3 to 12 percent slopes	26	VIIs-1	------	Very Shallow	38
PuA	Pullman clay loam, 0 to 1 percent slopes	27	IIIe-5	IIs-1	Clay Loam	35
PuB	Pullman clay loam, 1 to 3 percent slopes	28	IIIe-1	IIIe-1	Clay Loam	35
Ra	Randall clay	28	VIw-1	------	---------------	--
TuA	Tulia loam, 0 to 1 percent slopes	30	IVe-2	IIIe-4	Hardland Slopes	36
TuB	Tulia loam, 1 to 3 percent slopes	30	IVe-2	IIIe-4	Hardland Slopes	36
TwC	Tulia-Potter complex, 1 to 5 percent slopes	31	IVe-3	IVe-2	Hardland Slopes	36
ZcA	Zita loam, 0 to 1 percent slopes	31	IIIe-6	IIe-1	Clay Loam	35

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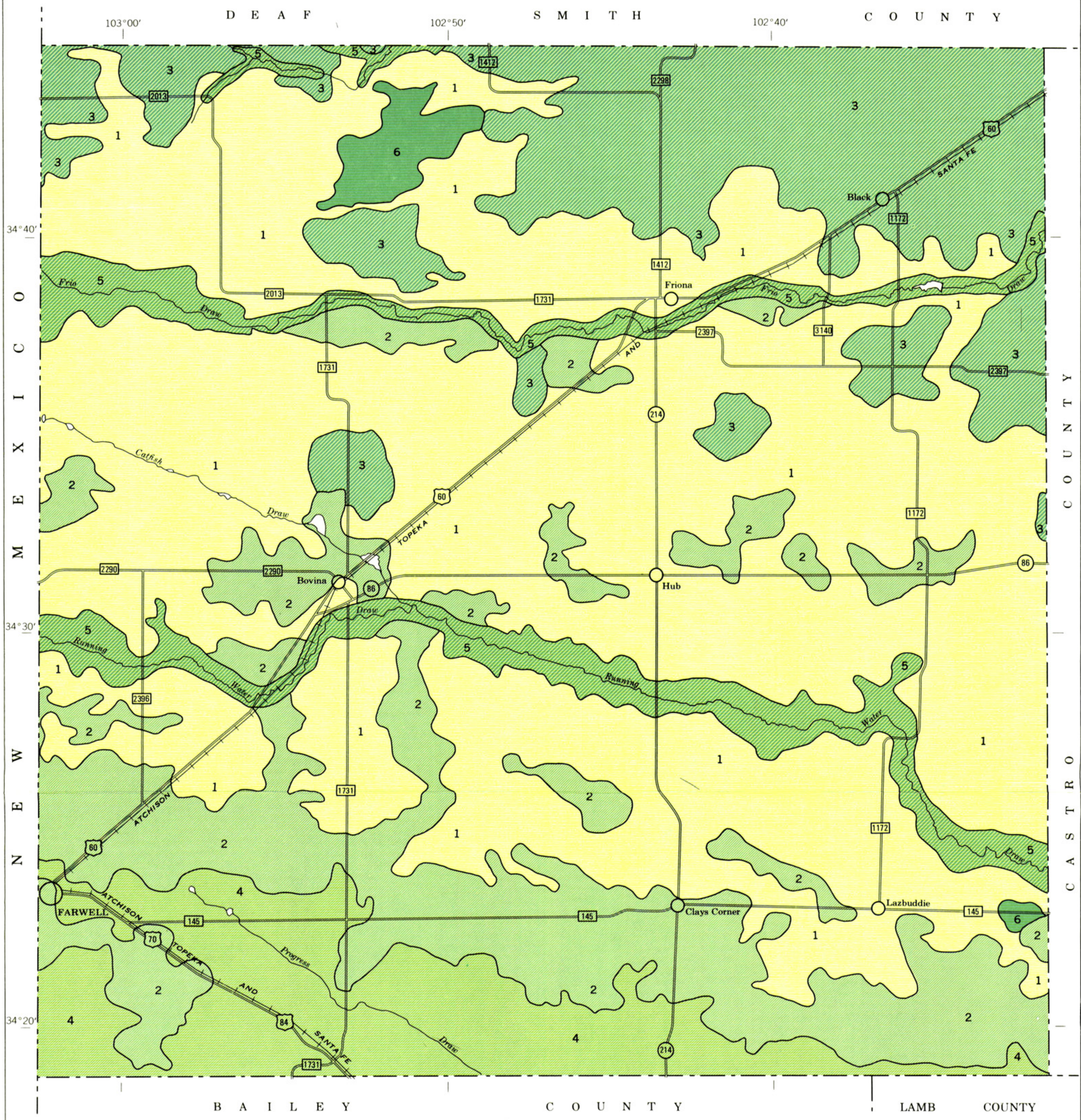


SOIL ASSOCIATIONS*

1	Olton association: Nearly level to gently sloping noncalcareous, moderately slowly permeable clay loams on uplands
2	Acuff association: Nearly level to gently sloping, noncalcareous, moderately permeable loams on uplands
3	Pullman association: Nearly level to gently sloping, noncalcareous, very slowly permeable clay loams on uplands
4	Amarillo association: Nearly level to gently sloping, noncalcareous, moderately permeable fine sandy loams on uplands
5	Berda–Estacado–Bippus association: Nearly level to sloping, noncalcareous to calcareous, moderately permeable loams and clay loams on sides and bottoms of draws
6	Estacado–Tulia association: Nearly level to gently sloping, calcareous, moderately permeable clay loams to loams on uplands

* Texture terms refer to the surface layer of the major soils.

Compiled 1975

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

N

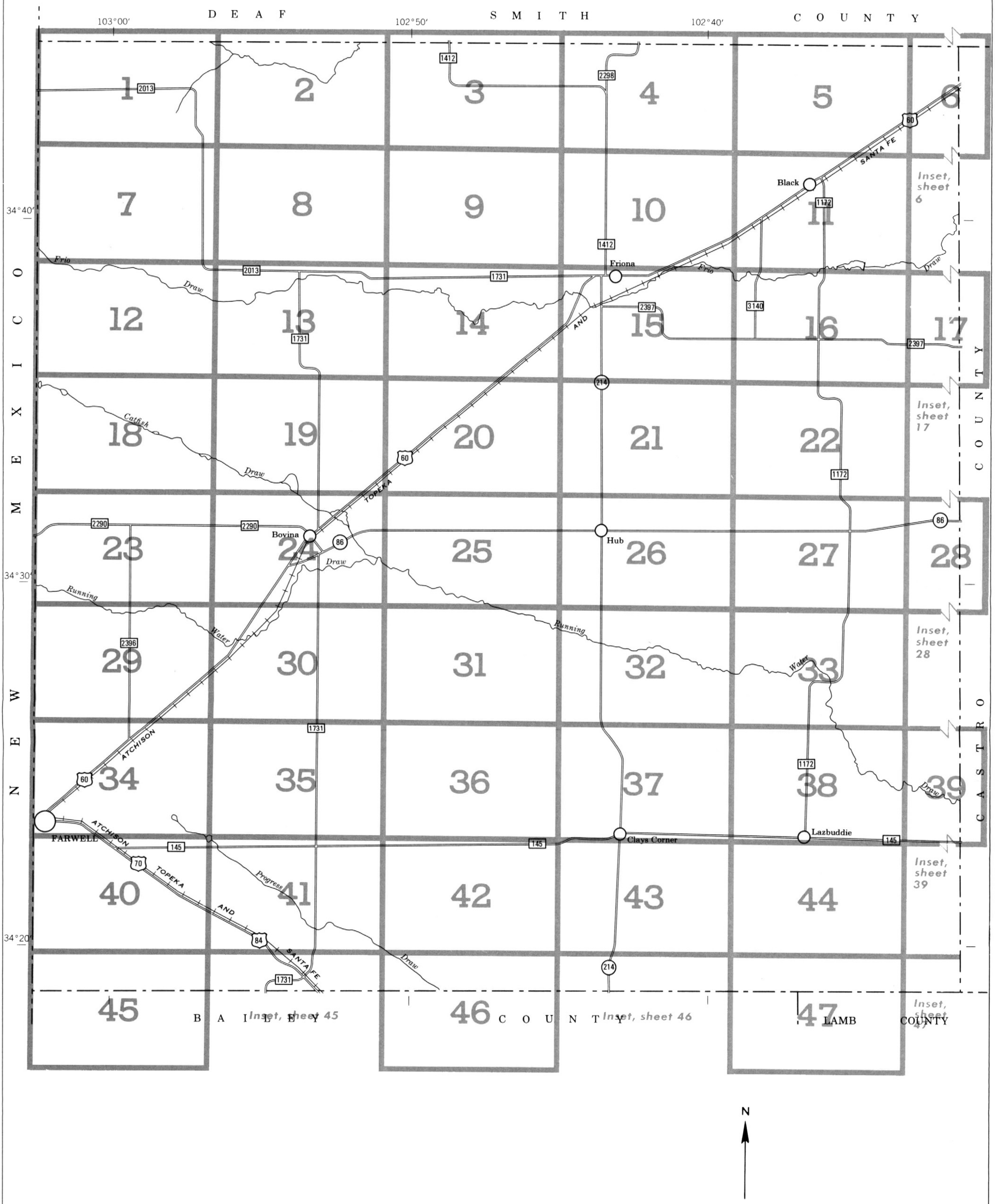
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
TEXAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

PARMER COUNTY, TEXAS

Scale 1:190,080

1 0 1 2 3 4 Miles



INDEX TO MAP SHEETS
PARMER COUNTY, TEXAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, or E, shows the slope. Most symbols without a slope letter are those of nearly level soils, but one is for a soil that has a fair range of slope. (W) following the soil name indicates that signs of erosion, especially of local shifting of soil by wind, are evident in some places, but the degree of erosion cannot be estimated reliably.

SYMBOL	NAME
AcA	Acuff loam, 0 to 1 percent slopes
AcB	Acuff loam, 1 to 3 percent slopes
AcC	Acuff loam, 3 to 5 percent slopes
AmA	Amarillo fine sandy loam, 0 to 1 percent slopes (W)
AmB	Amarillo fine sandy loam, 1 to 3 percent slopes (W)
AmC	Amarillo fine sandy loam, 3 to 5 percent slopes (W)
ArA	Arvana fine sandy loam, 0 to 1 percent slopes (W)
BeC	Berda loam, 3 to 5 percent slopes
BeD	Berda loam, 5 to 8 percent slopes
BfA	Bippus fine sandy loam, 0 to 1 percent slopes
BpA	Bippus clay loam, 0 to 1 percent slopes
BpB	Bippus clay loam, 1 to 3 percent slopes
Bs	Bippus and Spur soils, frequently flooded
EsA	Estacado clay loam, 0 to 1 percent slopes
EsB	Estacado clay loam, 1 to 3 percent slopes
EtC	Estacado-Posey complex, 3 to 5 percent slopes
FrA	Friona loam, 0 to 1 percent slopes
KmC	Kimbrough loam, 1 to 5 percent slopes
LkD	Likes loamy fine sand, 1 to 8 percent slopes (W)
Lp	Lipan clay, depressional
MoB	Mobeetie fine sandy loam, 0 to 3 percent slopes (W)
OtA	Olton clay loam, 0 to 1 percent slopes
OtB	Olton clay loam, 1 to 3 percent slopes
PfA	Posey fine sandy loam, 0 to 1 percent slopes (W)
PfB	Posey fine sandy loam, 1 to 3 percent slopes (W)
PmD	Posey-Berda complex, 5 to 8 percent slopes
PoE	Potter loam, 3 to 12 percent slopes
PuA	Pullman clay loam, 0 to 1 percent slopes
PuB	Pullman clay loam, 1 to 3 percent slopes
Ra	Randall clay
TuA	Tulia loam, 0 to 1 percent slopes
TuB	Tulia loam, 1 to 3 percent slopes
TwC	Tulia-Potter complex, 1 to 5 percent slopes
ZcA	Zita loam, 0 to 1 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Previously published soil survey
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Previously published boundary
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA; FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

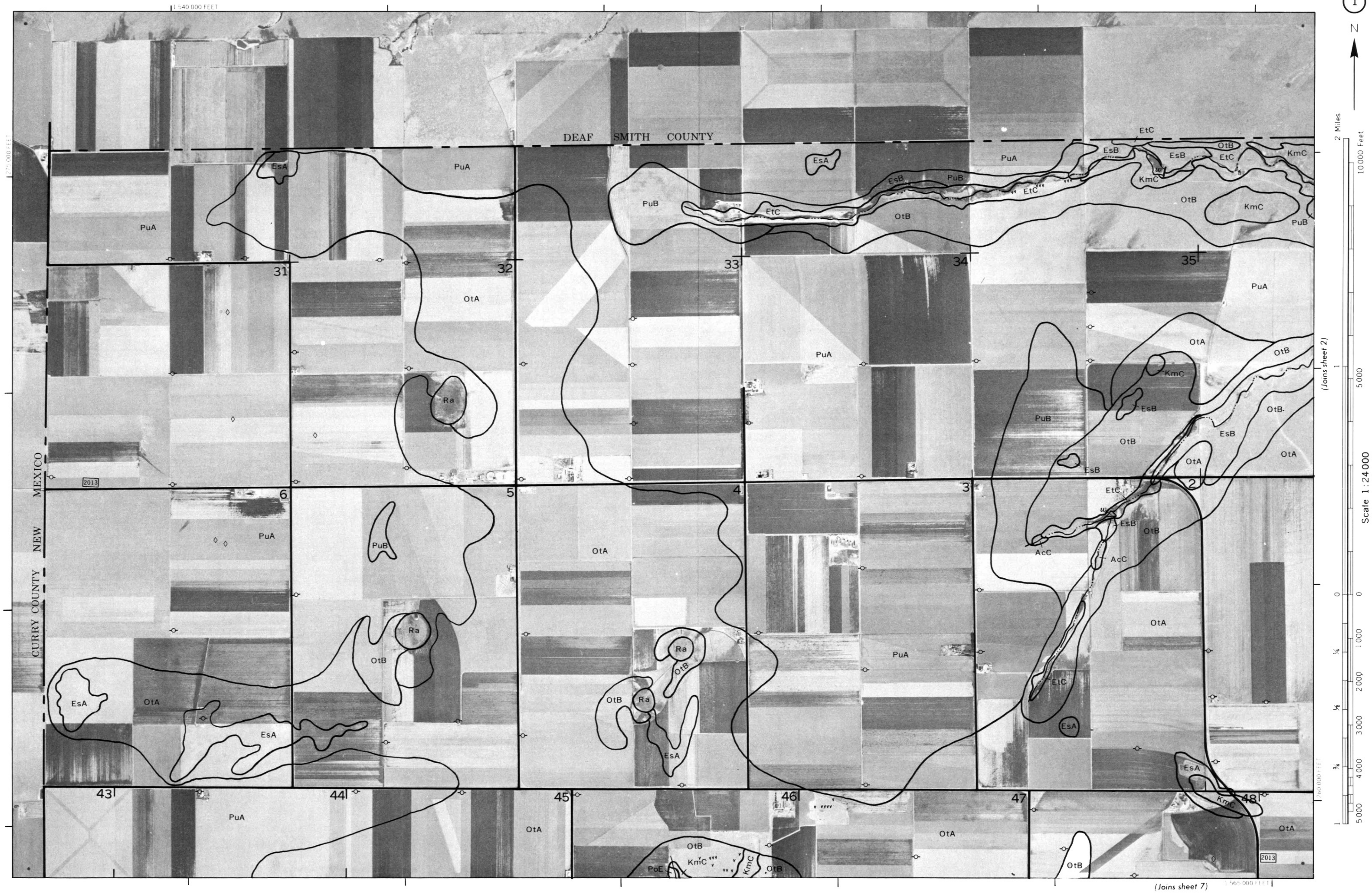
DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

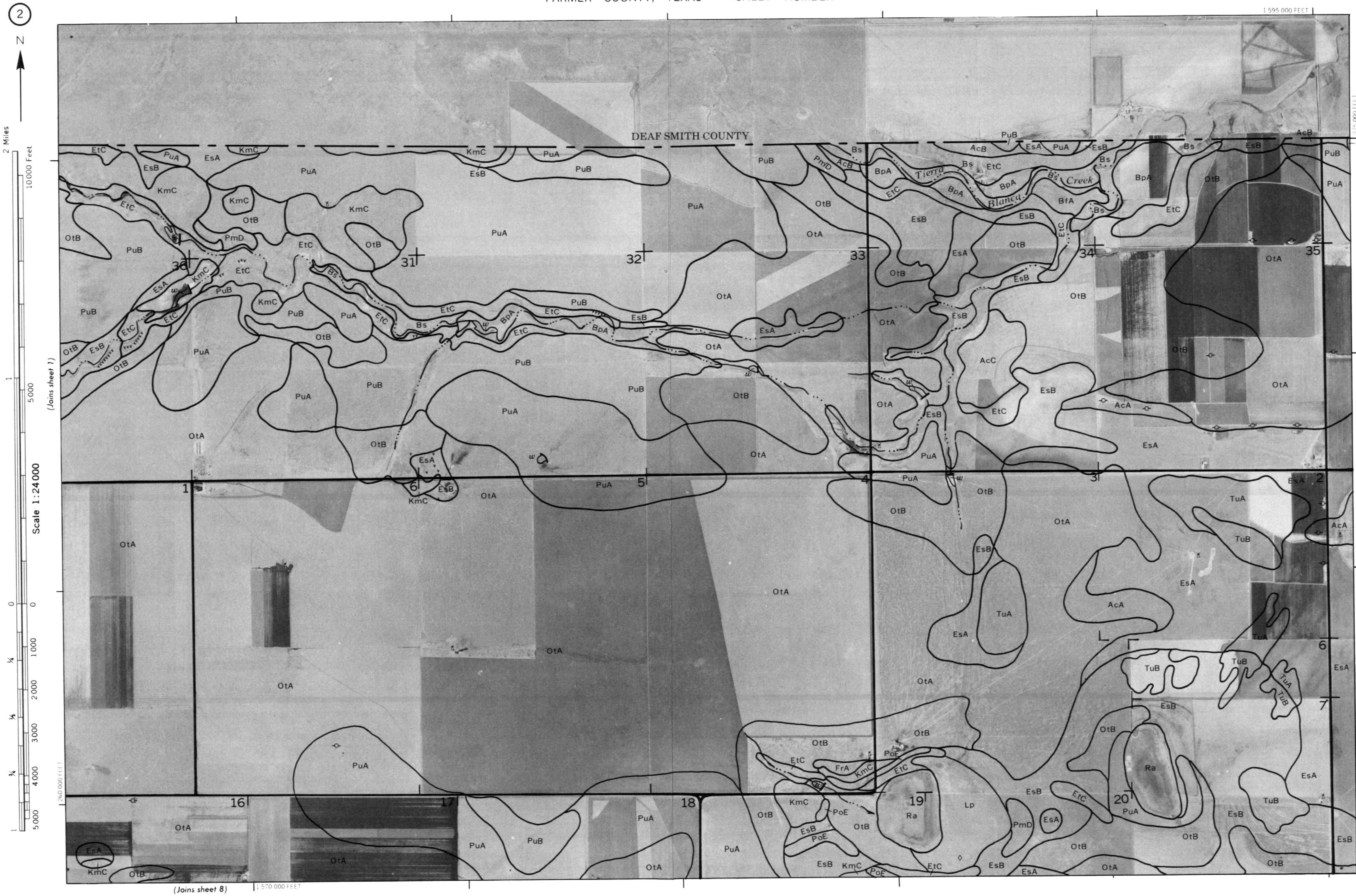
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

PARMER COUNTY, TEXAS — SHEET NUMBER 1



PARMER COUNTY, TEXAS NO. 1

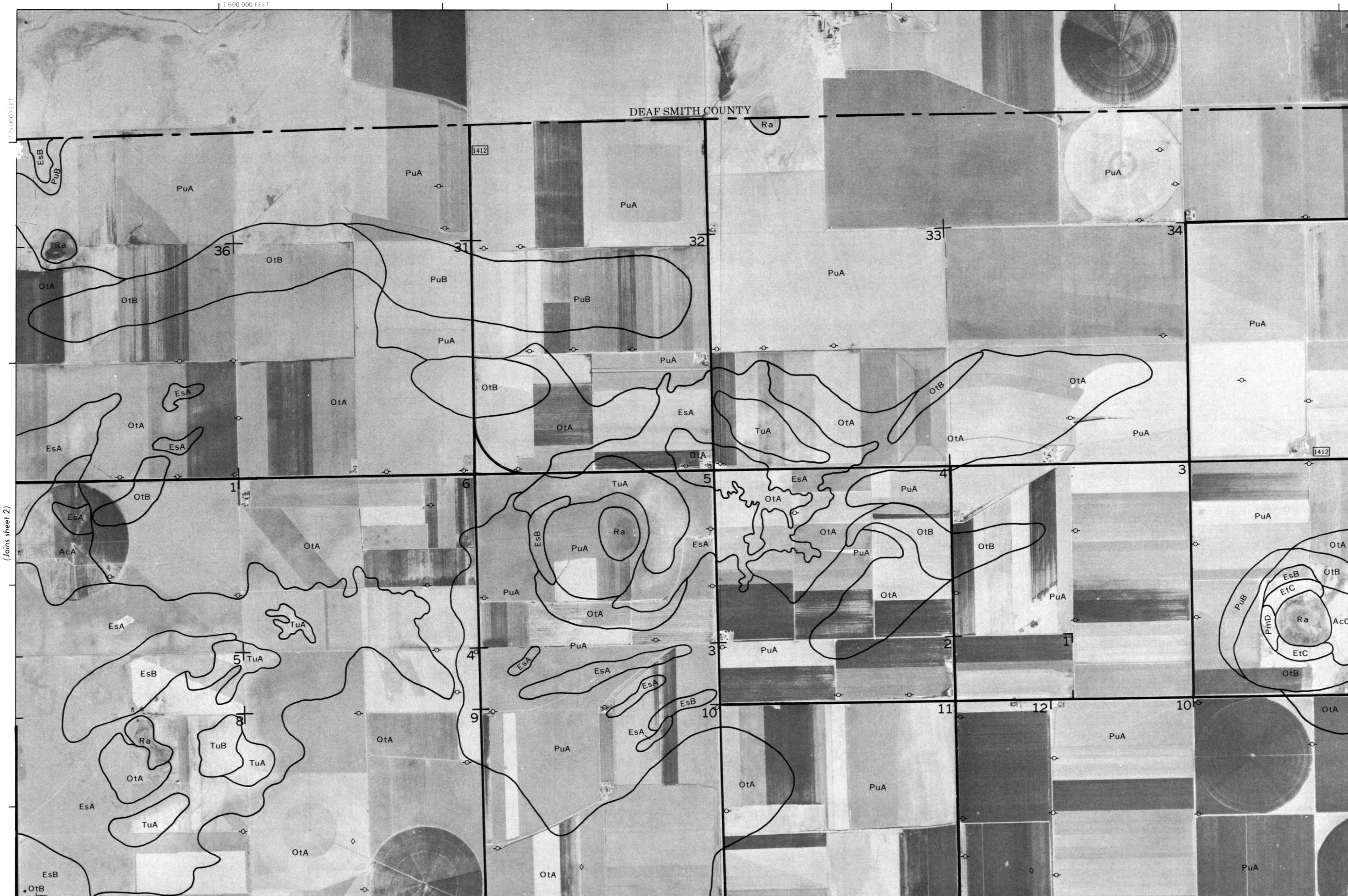
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 2

3



N

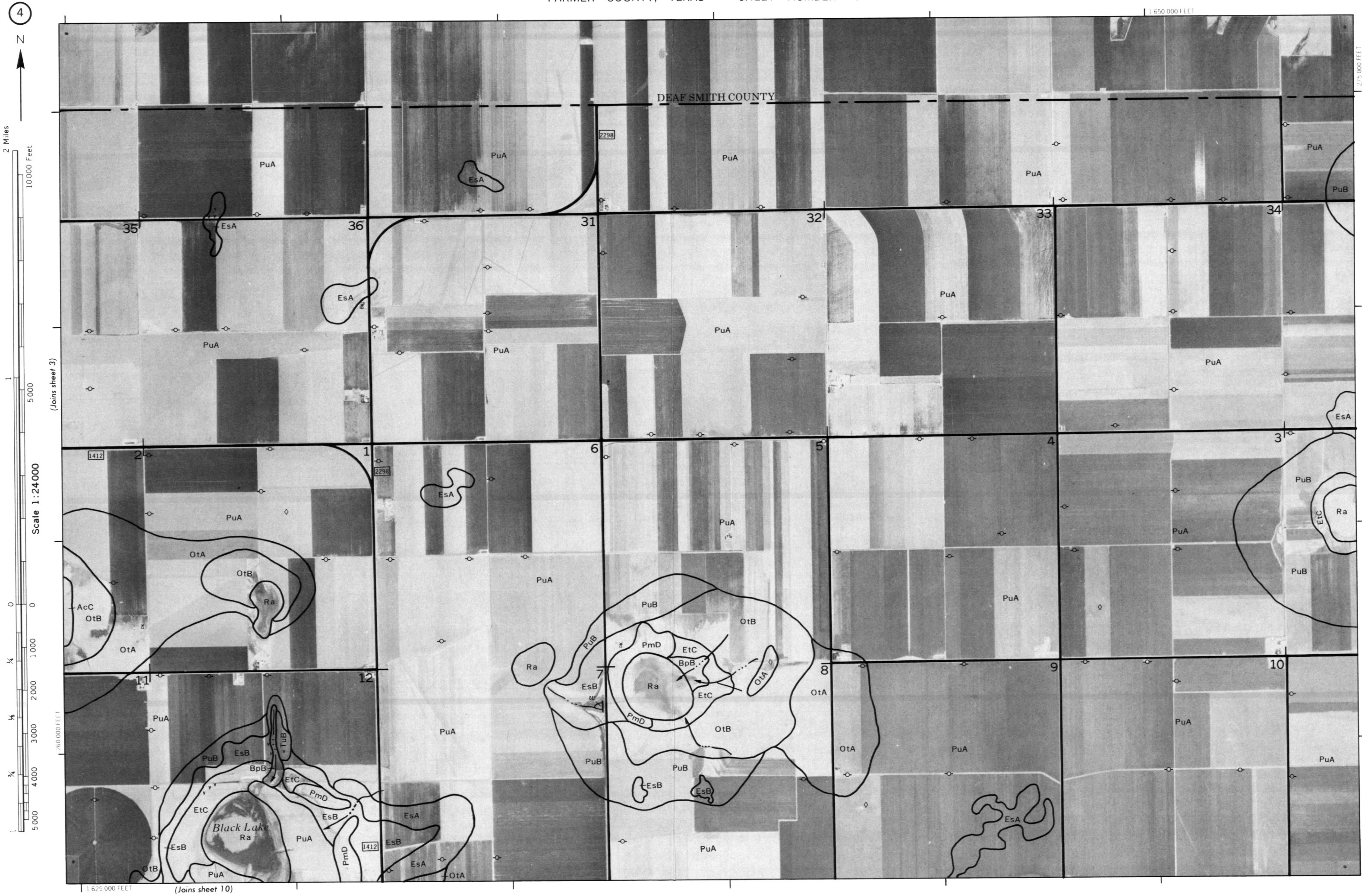
Scale 1:24000

2 Miles 1 0

10000 Feet 5000 0 1000 2000 3000 4000 5000

PARMER COUNTY, TEXAS NO. 3

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned

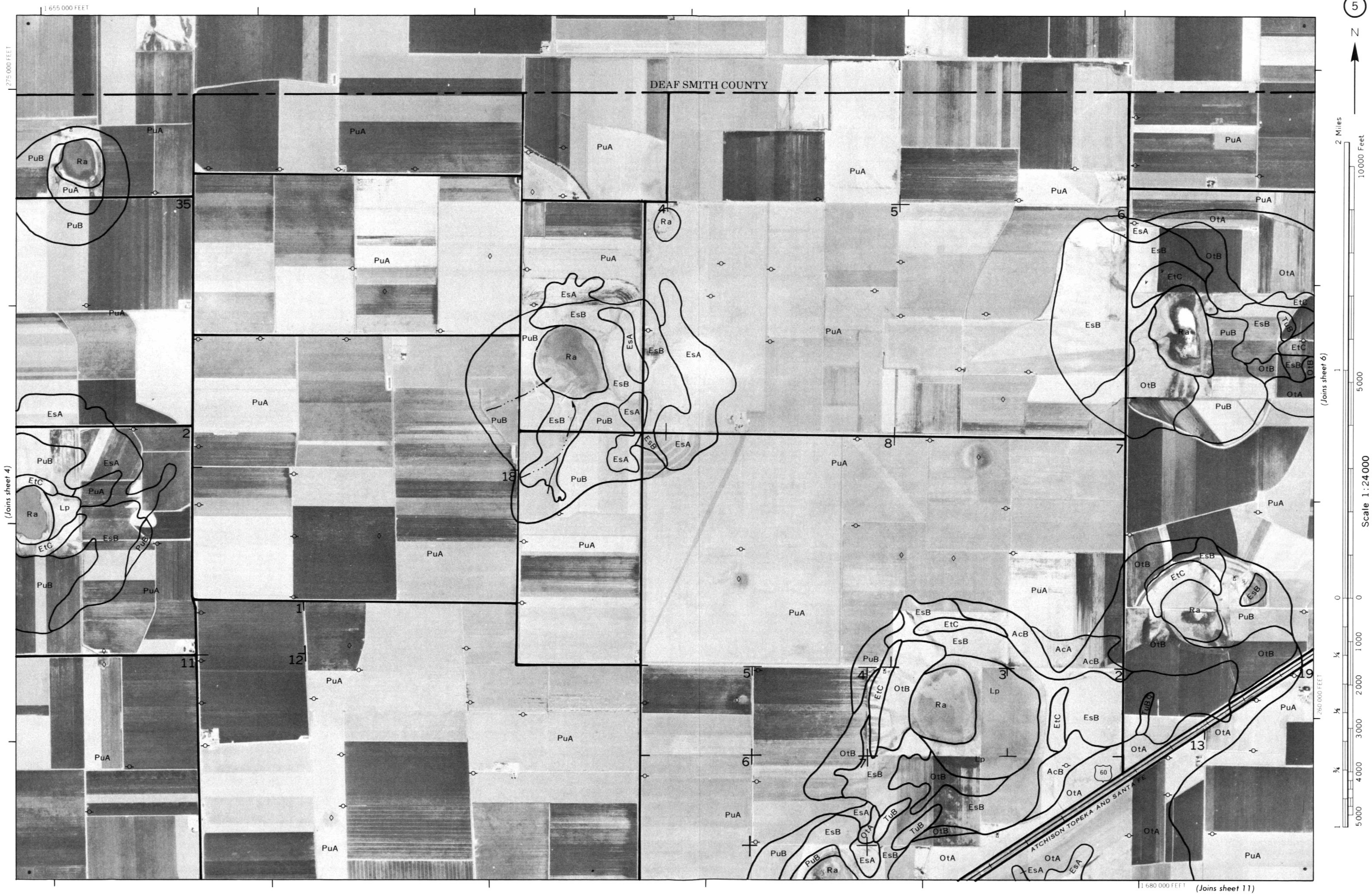


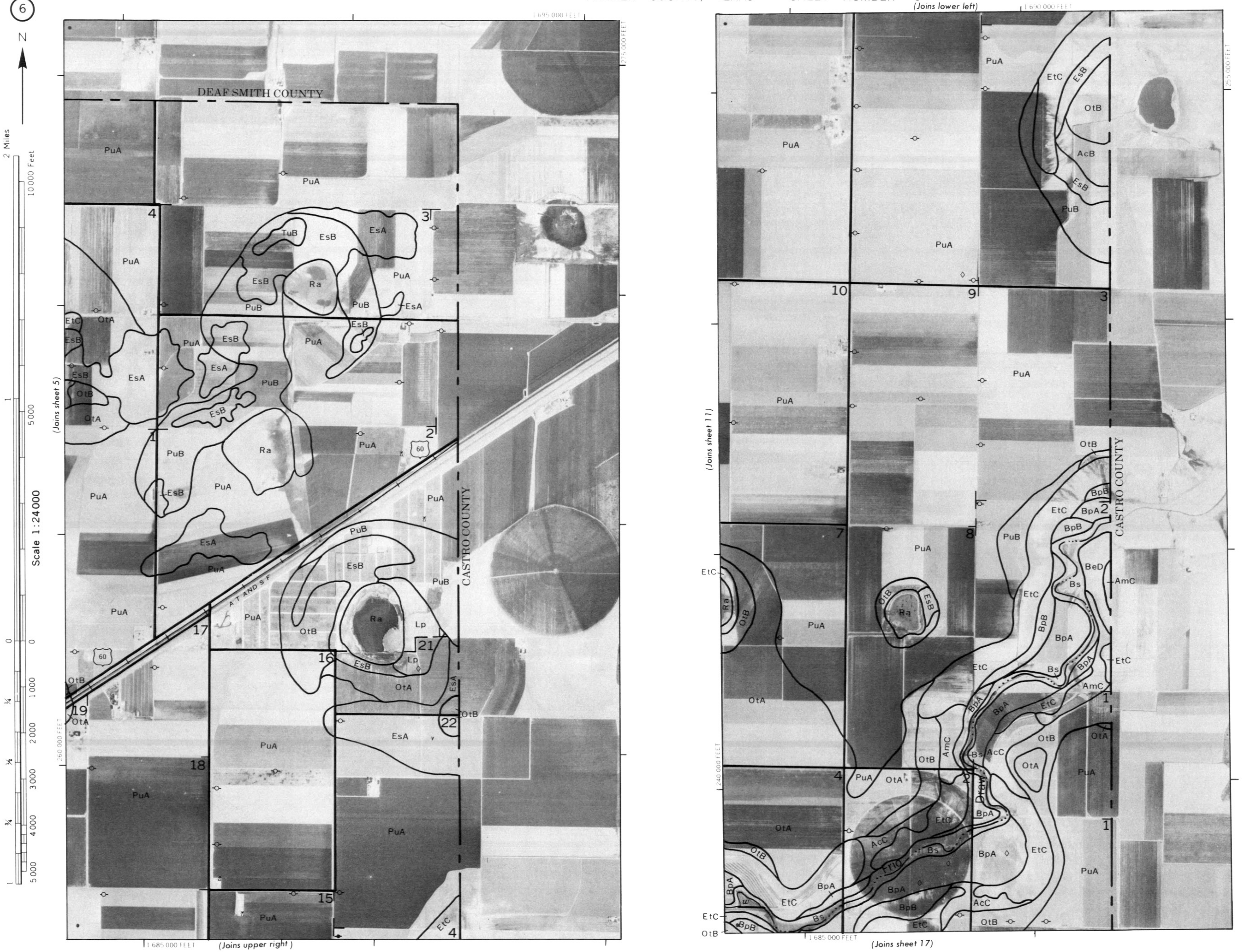
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 4

PARMER COUNTY, TEXAS NO. 5

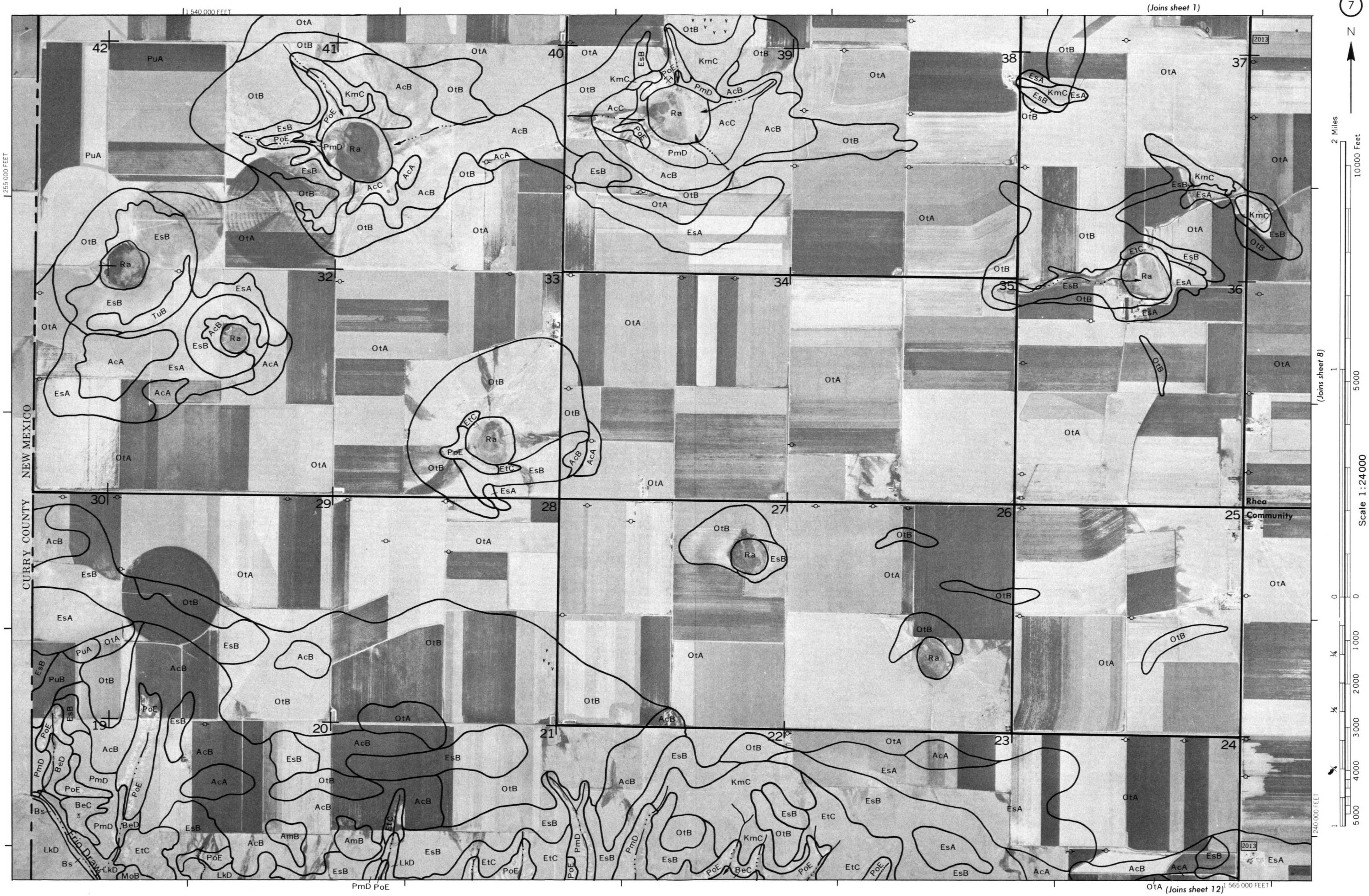
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 6



PARMER COUNTY, TEXAS NO. 7

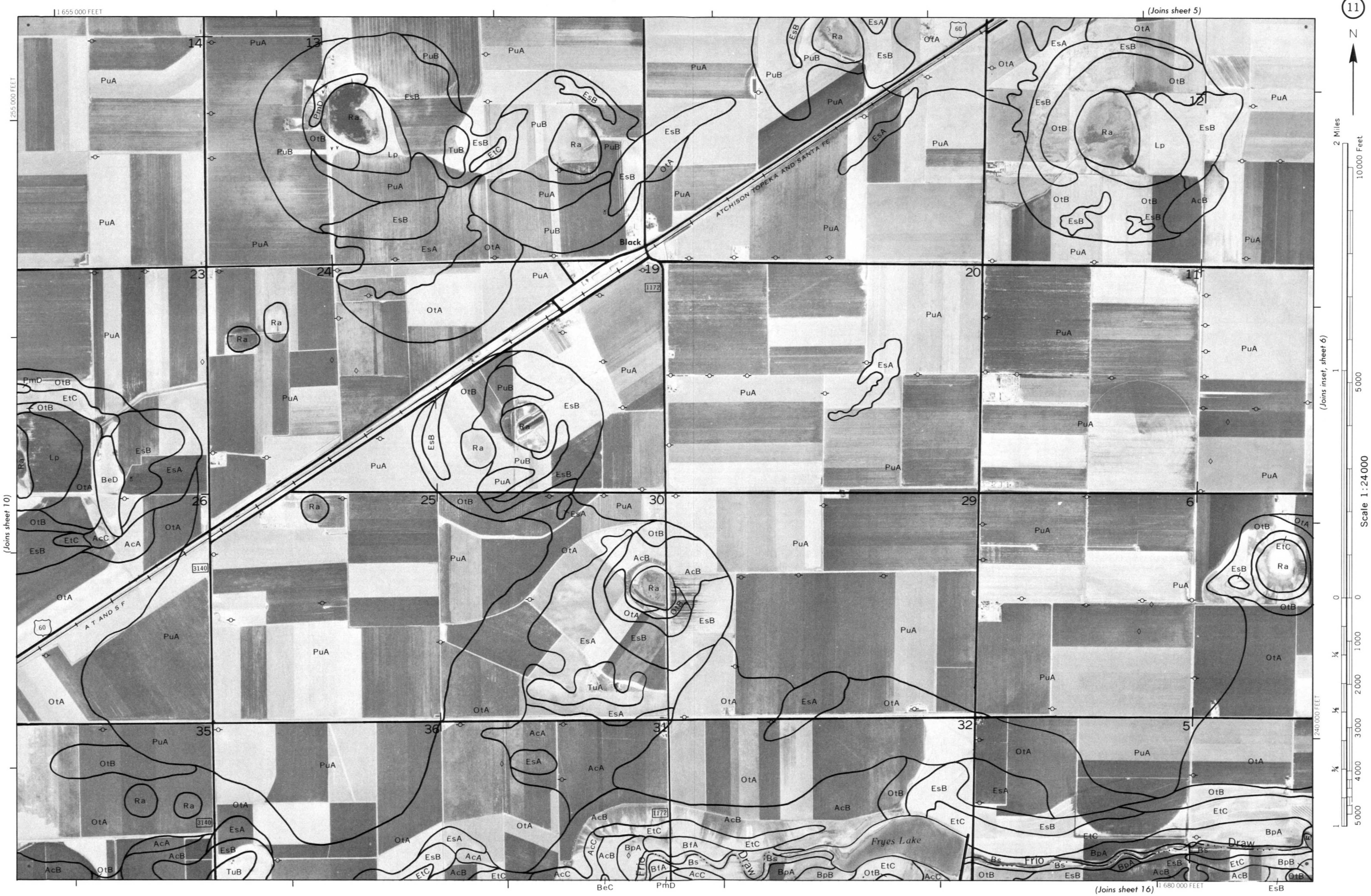
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


8
N
(Joins sheet 2)
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 13)
2 Miles
10 000 Feet
Scale 1:24 000
1 595 000 FEET
1 570 000 FEET
240 000 FEET
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.
PARMER COUNTY, TEXAS NO. 8


9
(Joins sheet 3)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 14)
PARMER COUNTY, TEXAS NO. 9
1 600 000 FEET
1 620 000 FEET
240 000 FEET
N
2 Miles
10000 Feet
Scale 1:24000
13
14
15
16
17
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
OtA
OtB
EsA
EsB
PuA
AcA
AcB
KmC
TuB
Lp
Ra
EtC
TwC
PfA
PfB
ZcA
w

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 10



PARMER COUNTY, TEXAS NO. 11

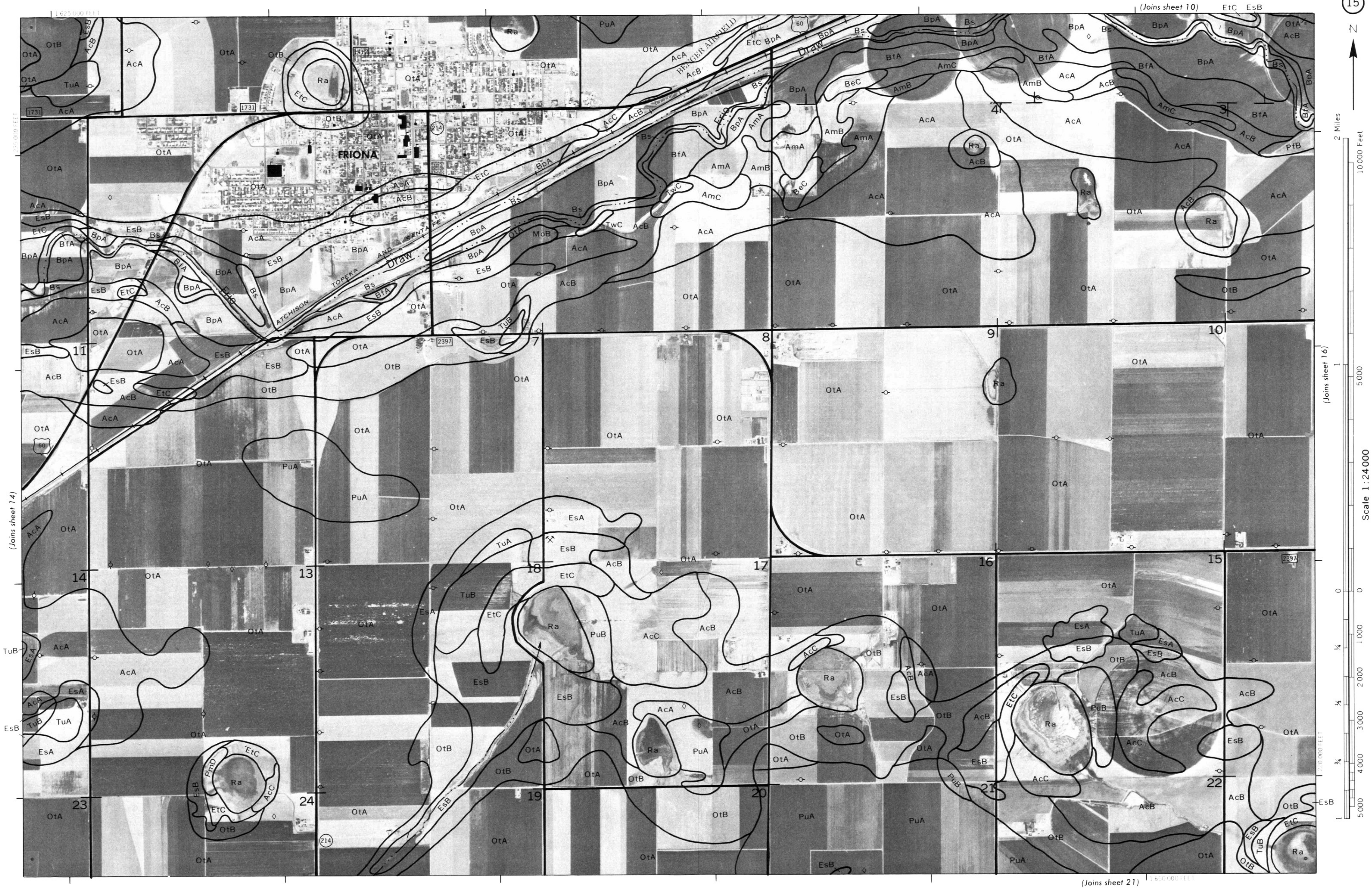
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 12

PARMER COUNTY, TEXAS NO. 13


14
N
2 Miles
10 000 Feet
5000
Scale 1:24000
(Joins sheet 9)
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 20)
620 000 FEET
1 595 000 FEET
220 000 FEET
Twin Lakes
Frio Draw
ATCHISON TOPEKA AND SANTA FE
1731
60
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17
21
22
23
OtA
OtB
PuA
AcA
AcB
AcC
AmB
BeC
BeD
BfA
BpA
Bs
EsA
EsB
EtC
PfB
Ra
TuA
TuB
TwC
Lp



PARMER COUNTY, TEXAS NO. 15

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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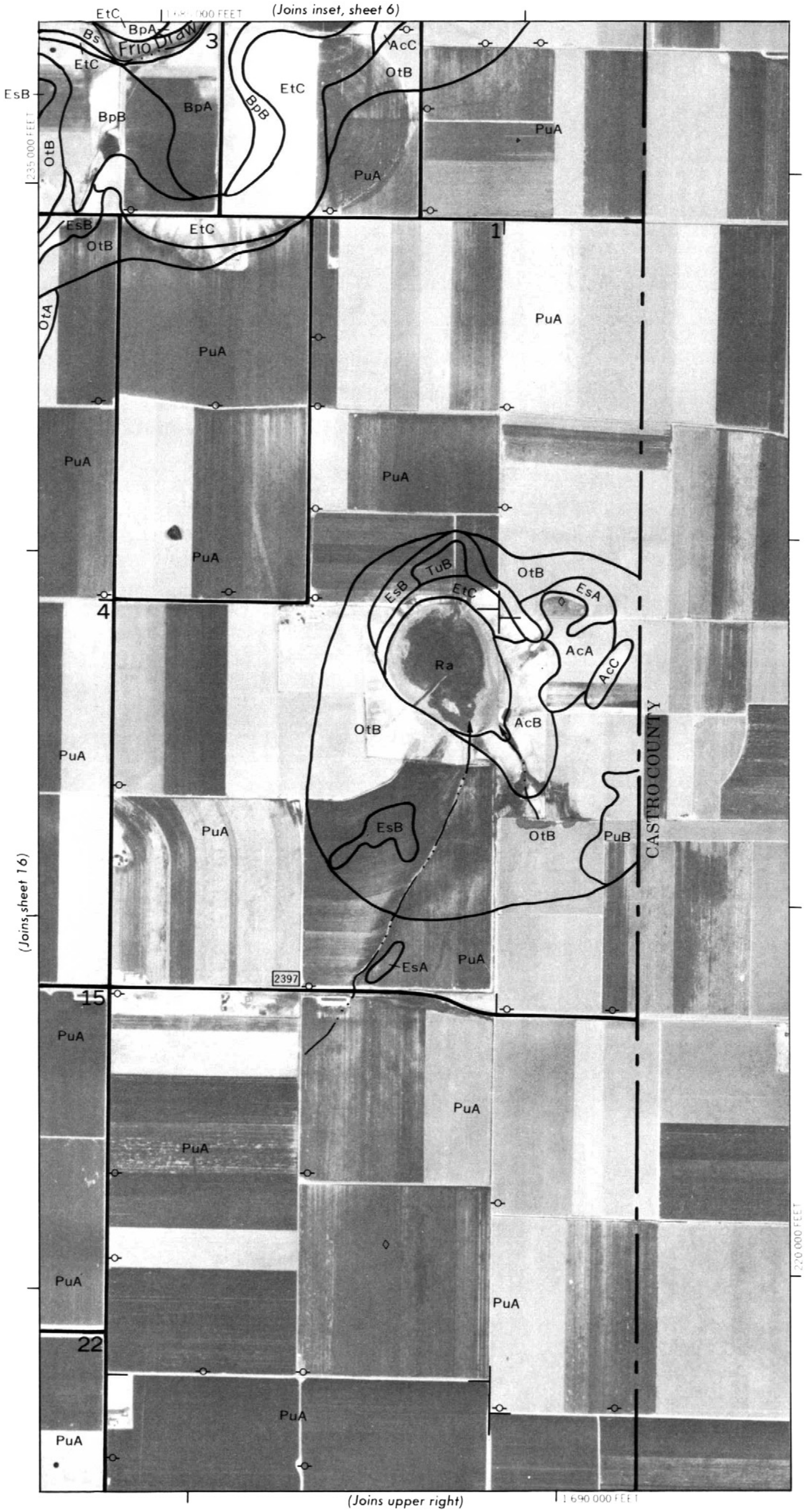
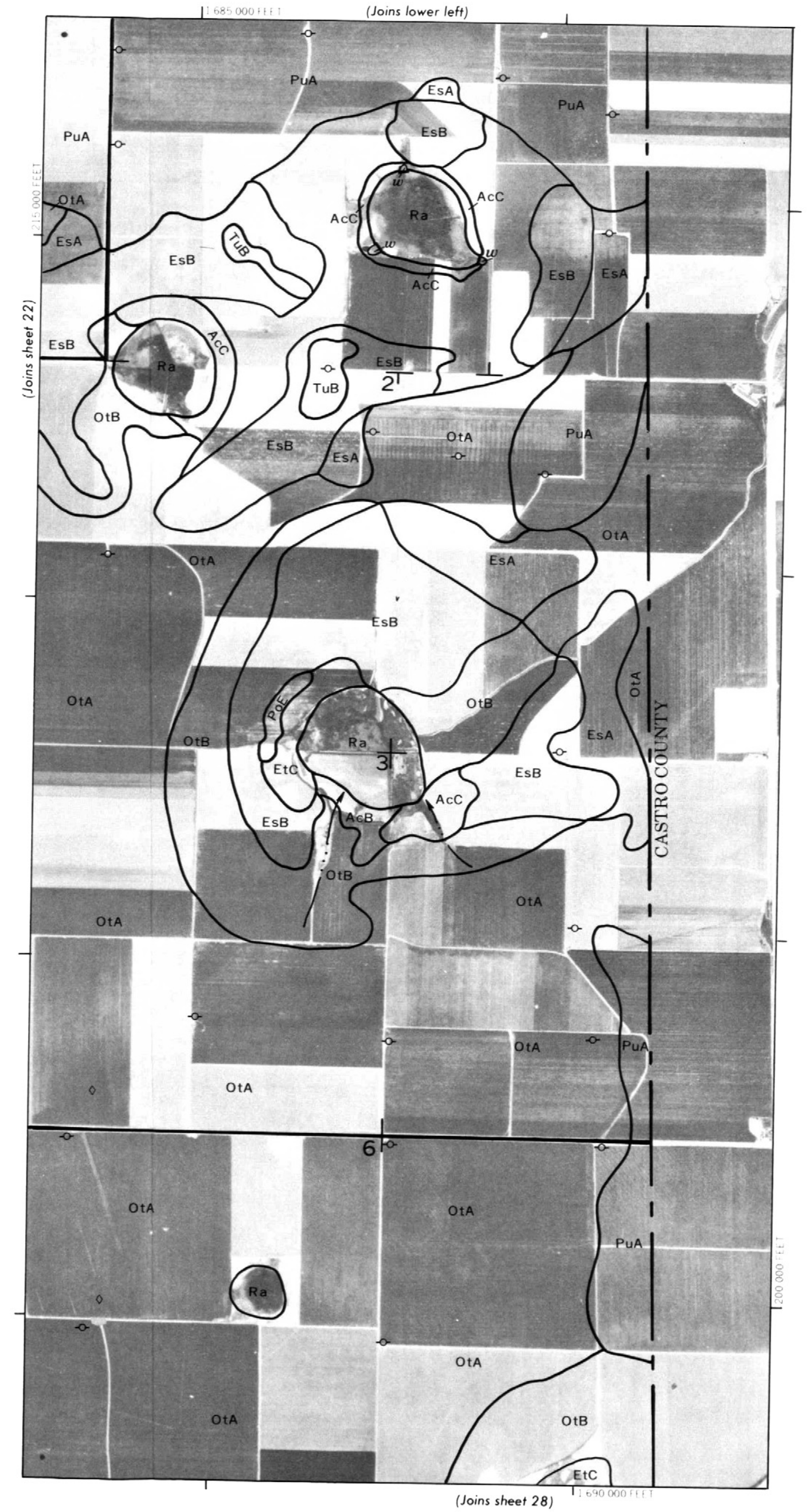
PARMER COUNTY, TEXAS NO. 16

PARMER COUNTY, TEXAS NO. 17

This map is compiled on 1972 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.





PARMER COUNTY, TEXAS — SHEET NUMBER 18

N

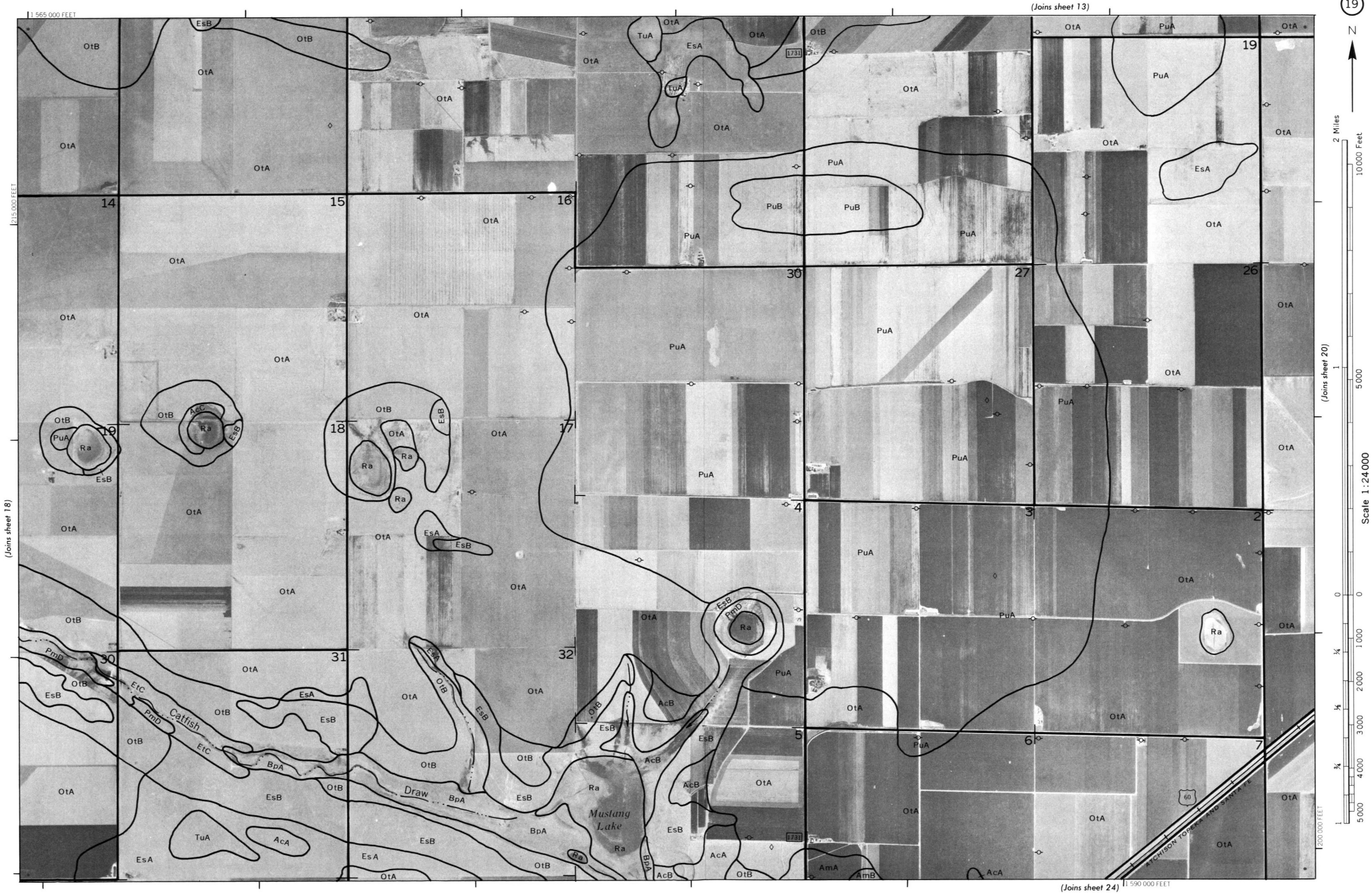
(Joins sheet 12)

(Joins sheet 23)

(Joins sheet 19)

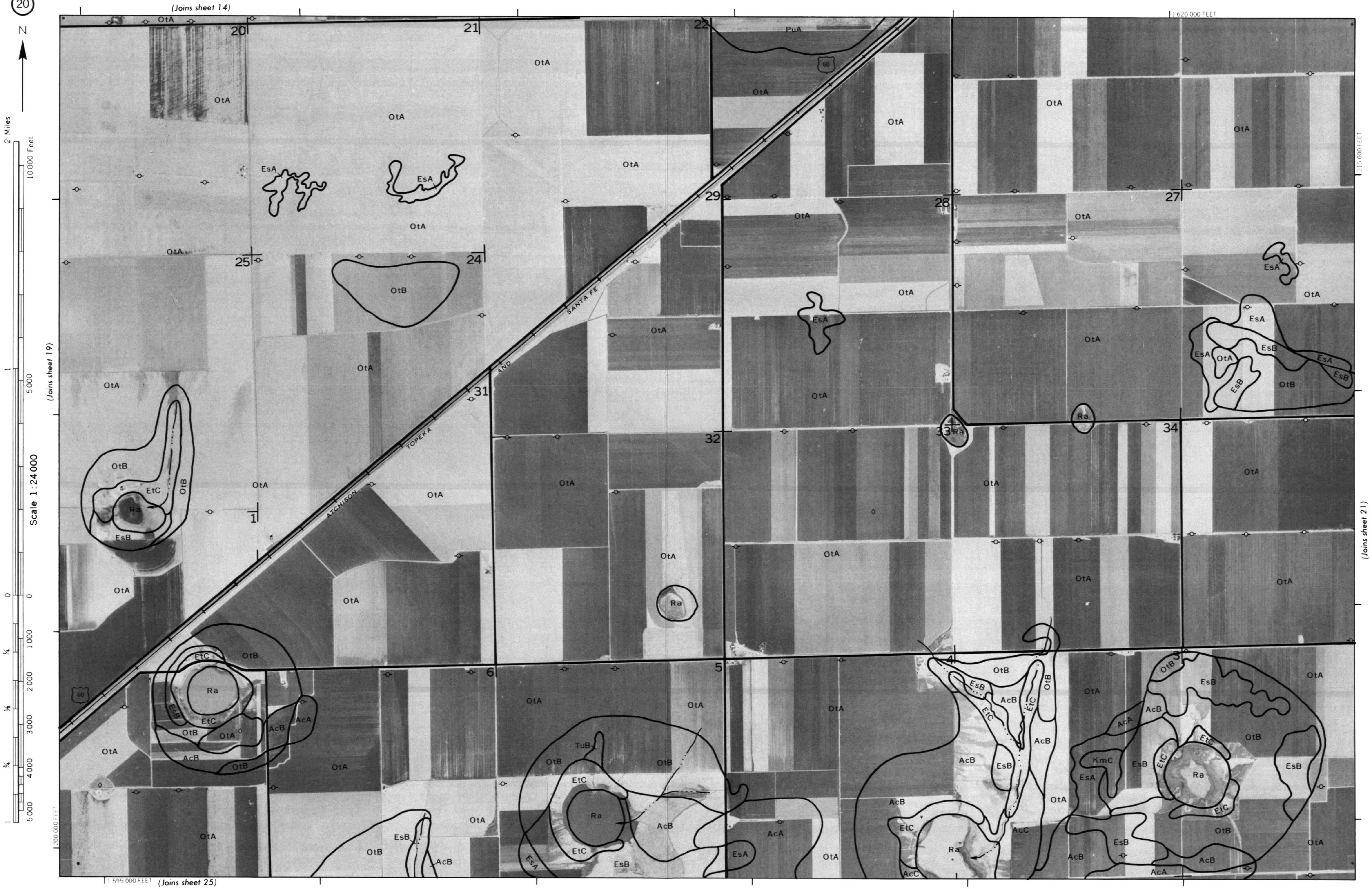
2 Miles
10 000 Feet
1
5000
Scale 1:24 000
0
0
1000
2000
3000
4000
5000
¼
½
¾
1

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

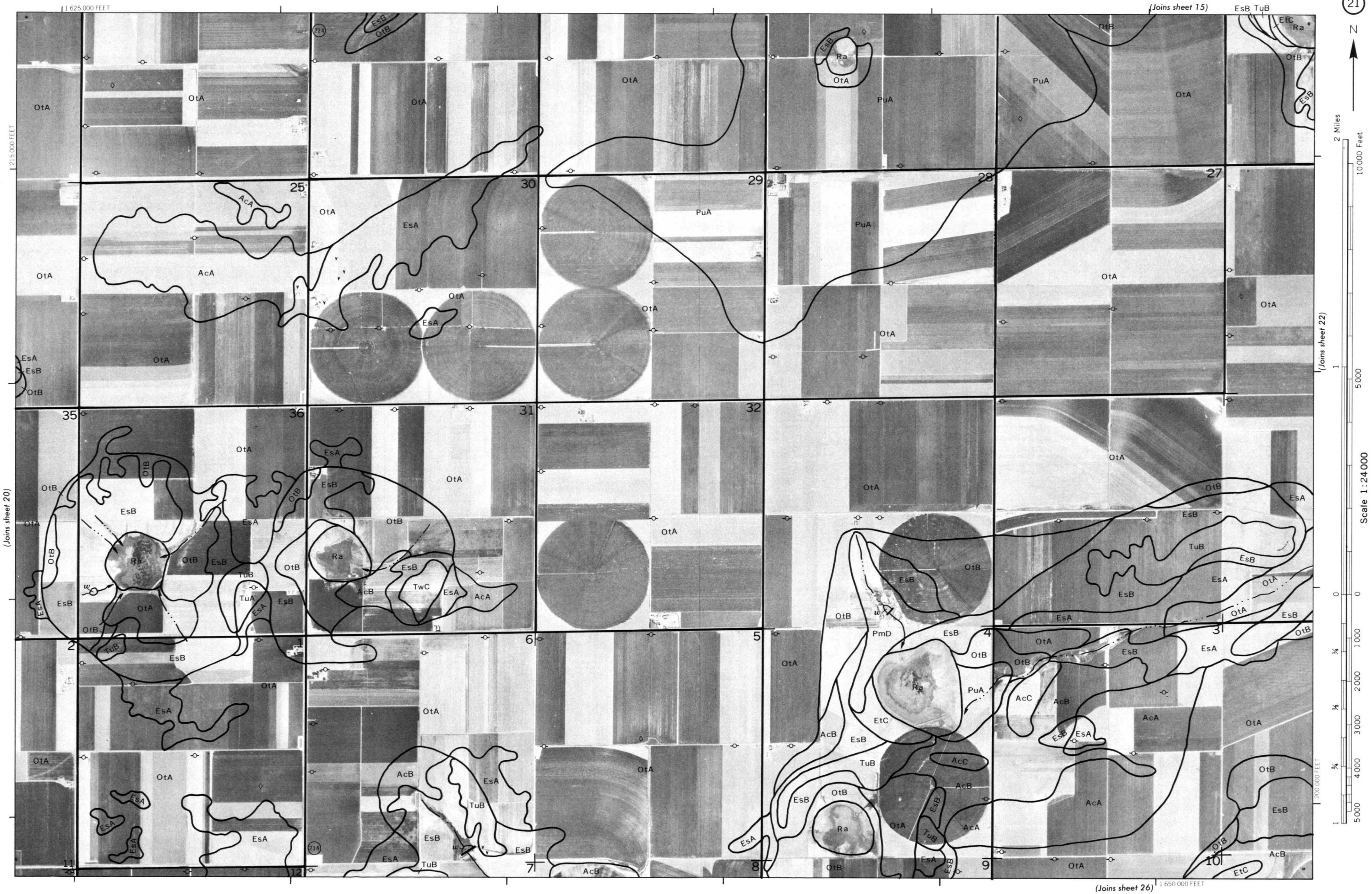


PARMER COUNTY, TEXAS NO. 19

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

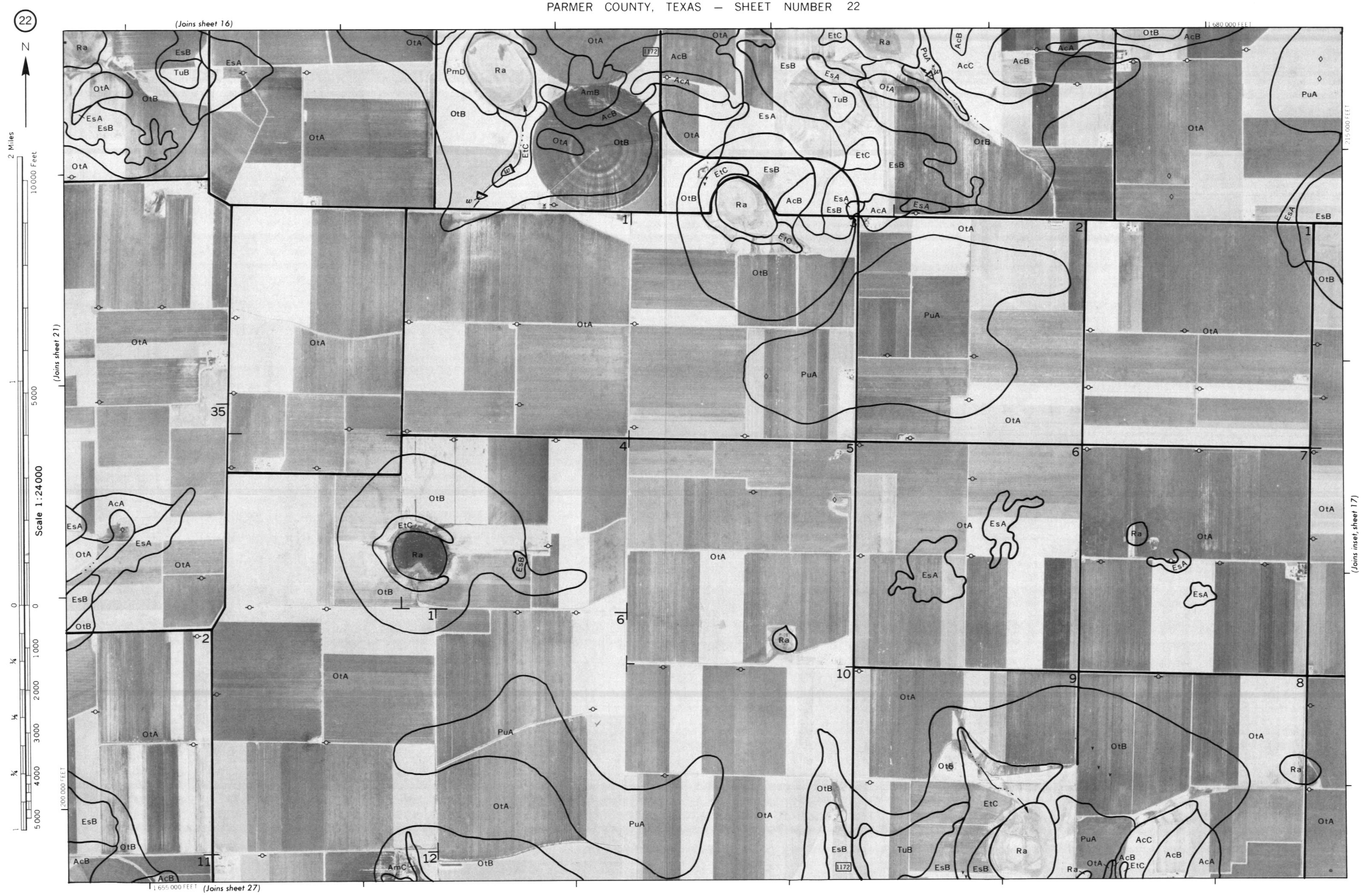


This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



PARMER COUNTY, TEXAS NO. 21

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 22

PARMER COUNTY, TEXAS — SHEET NUMBER 23

PARMER COUNTY, TEXAS NO. 23

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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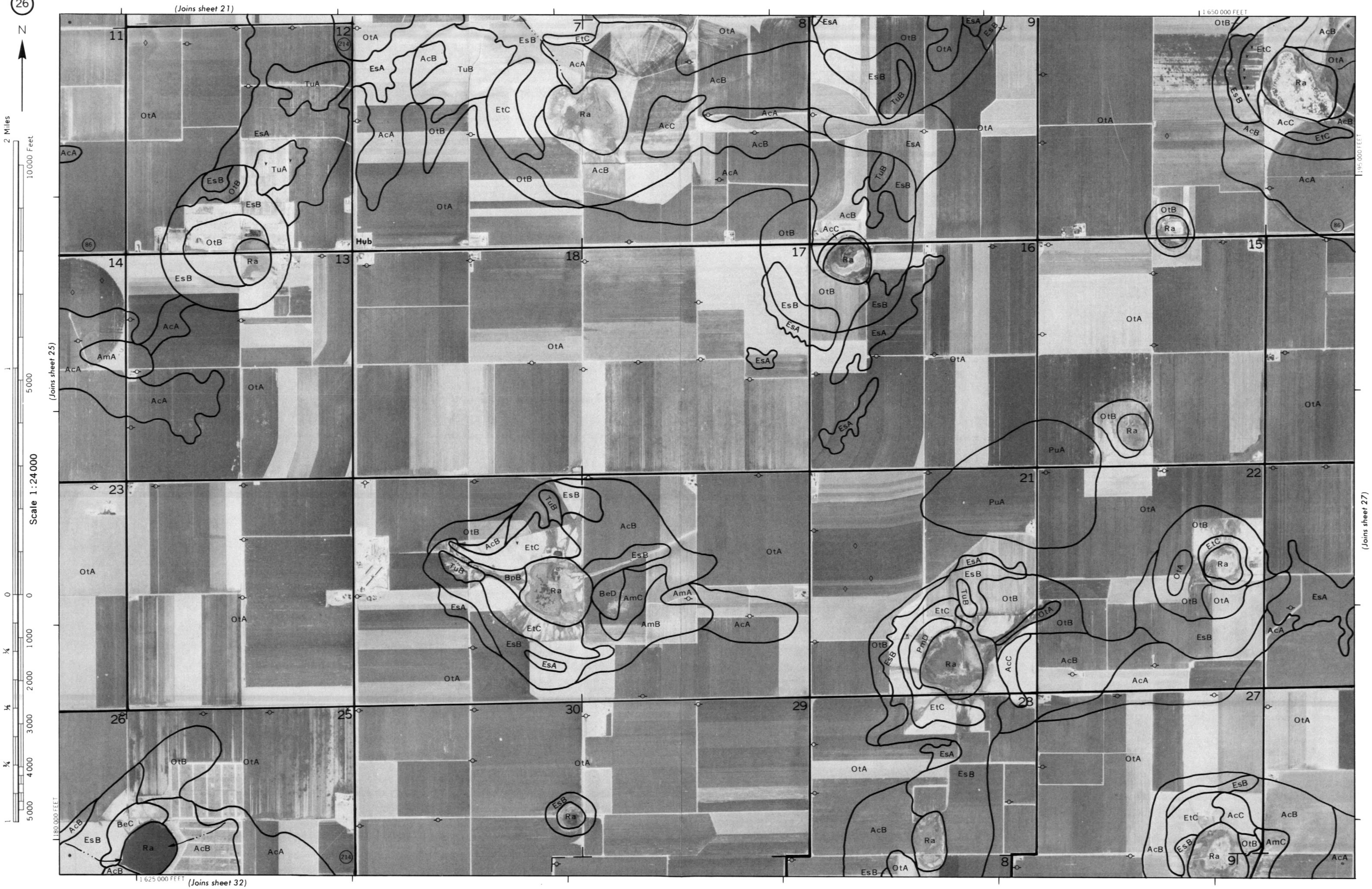
PARMER COUNTY, TEXAS NO. 24

25

PARMER COUNTY, TEXAS NO. 25

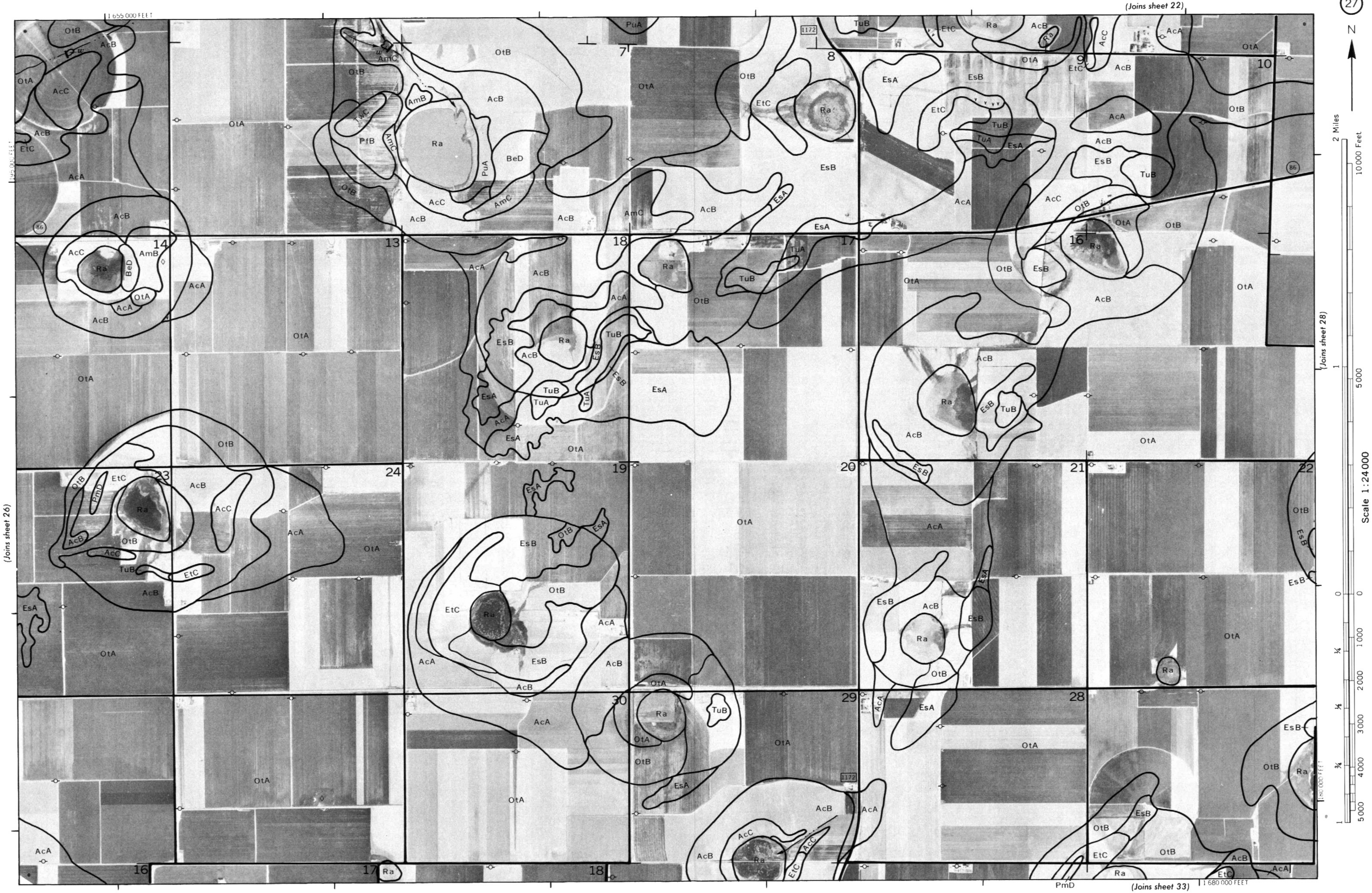


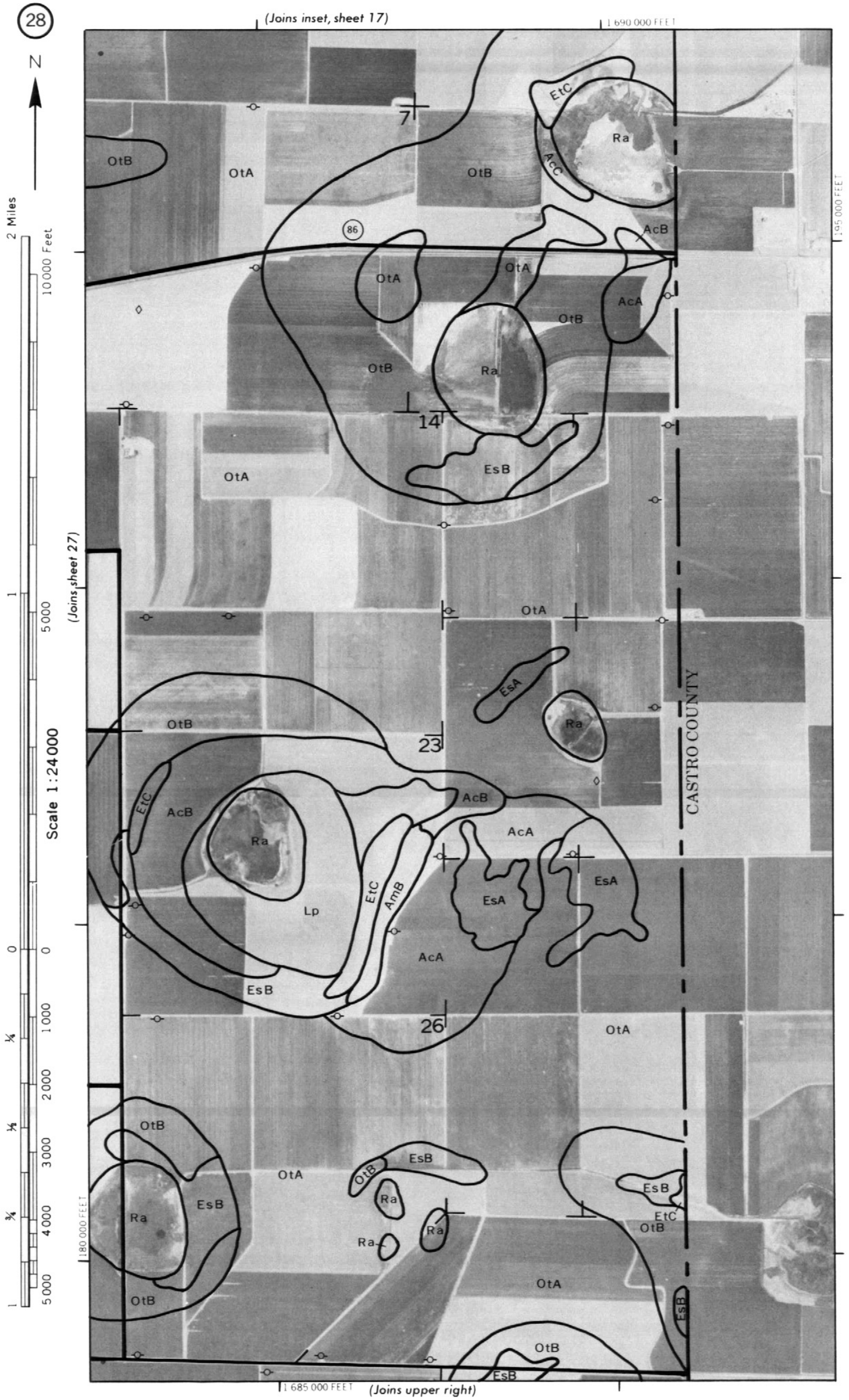
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

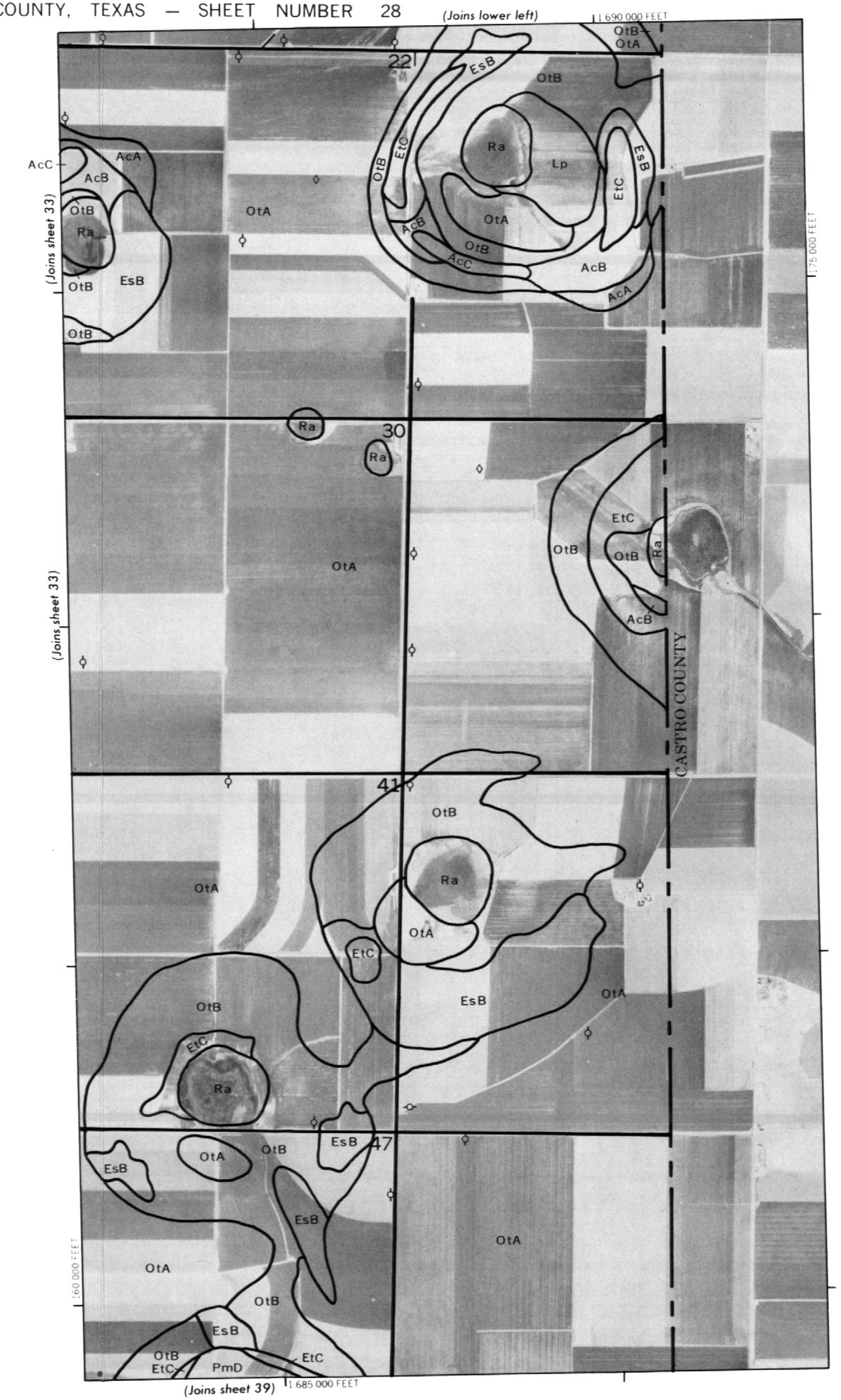
PARMER COUNTY, TEXAS NO. 26

PARMER COUNTY, TEXAS NO. 27

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

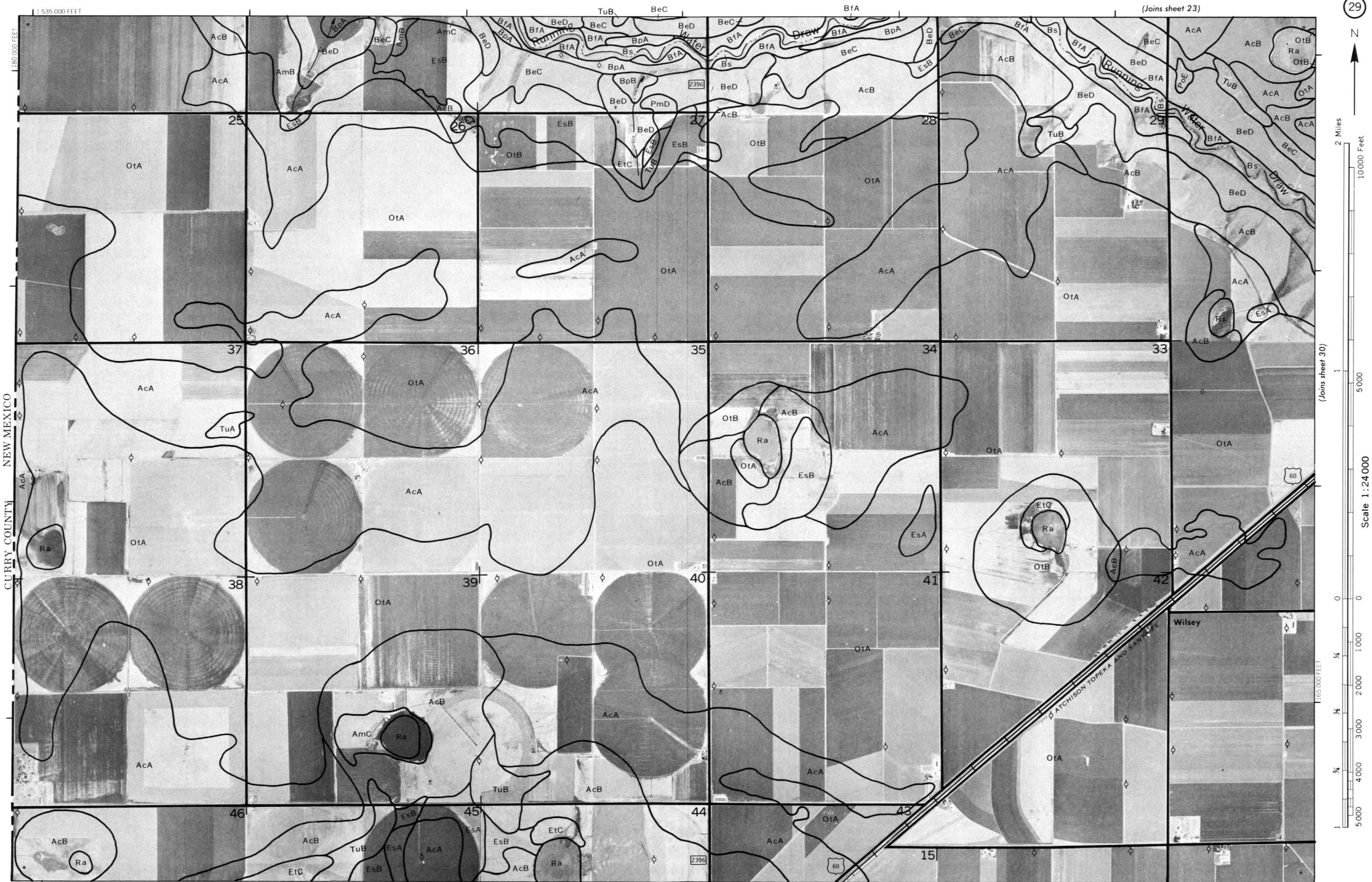






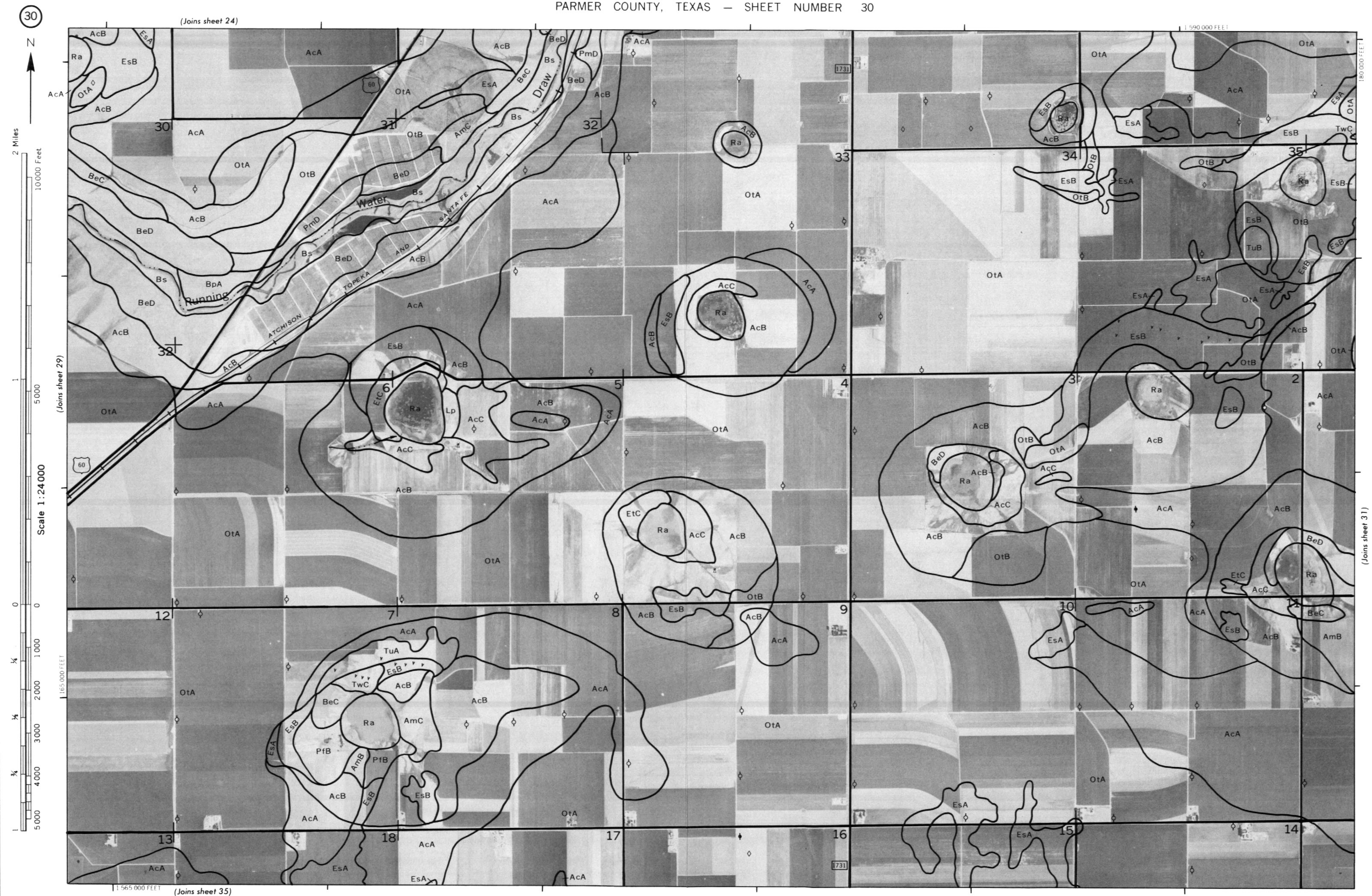
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

29

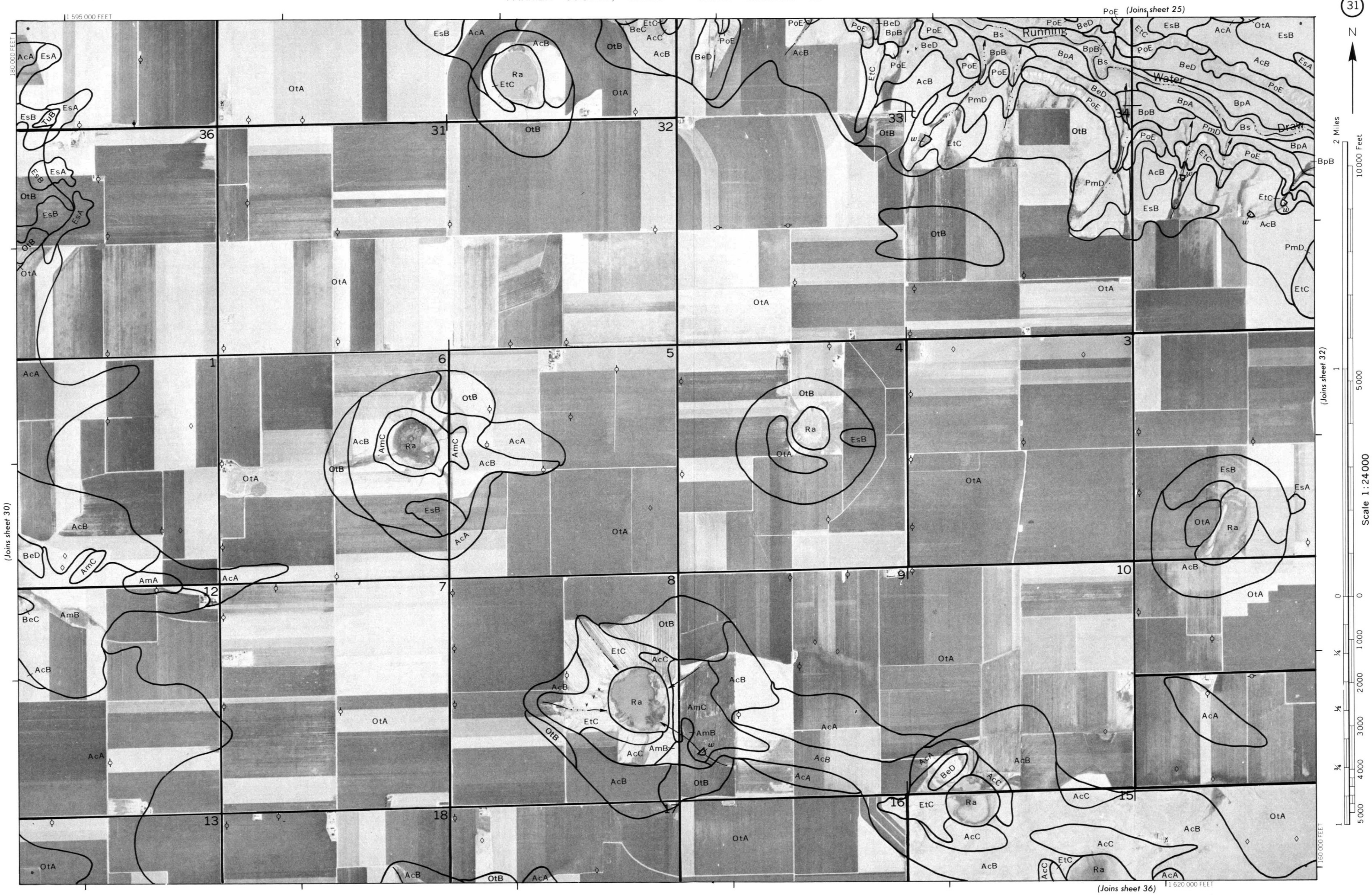


PARMER COUNTY, TEXAS NO. 29

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



PARMER COUNTY, TEXAS NO. 31

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

33

PARMER COUNTY, TEXAS NO. 33

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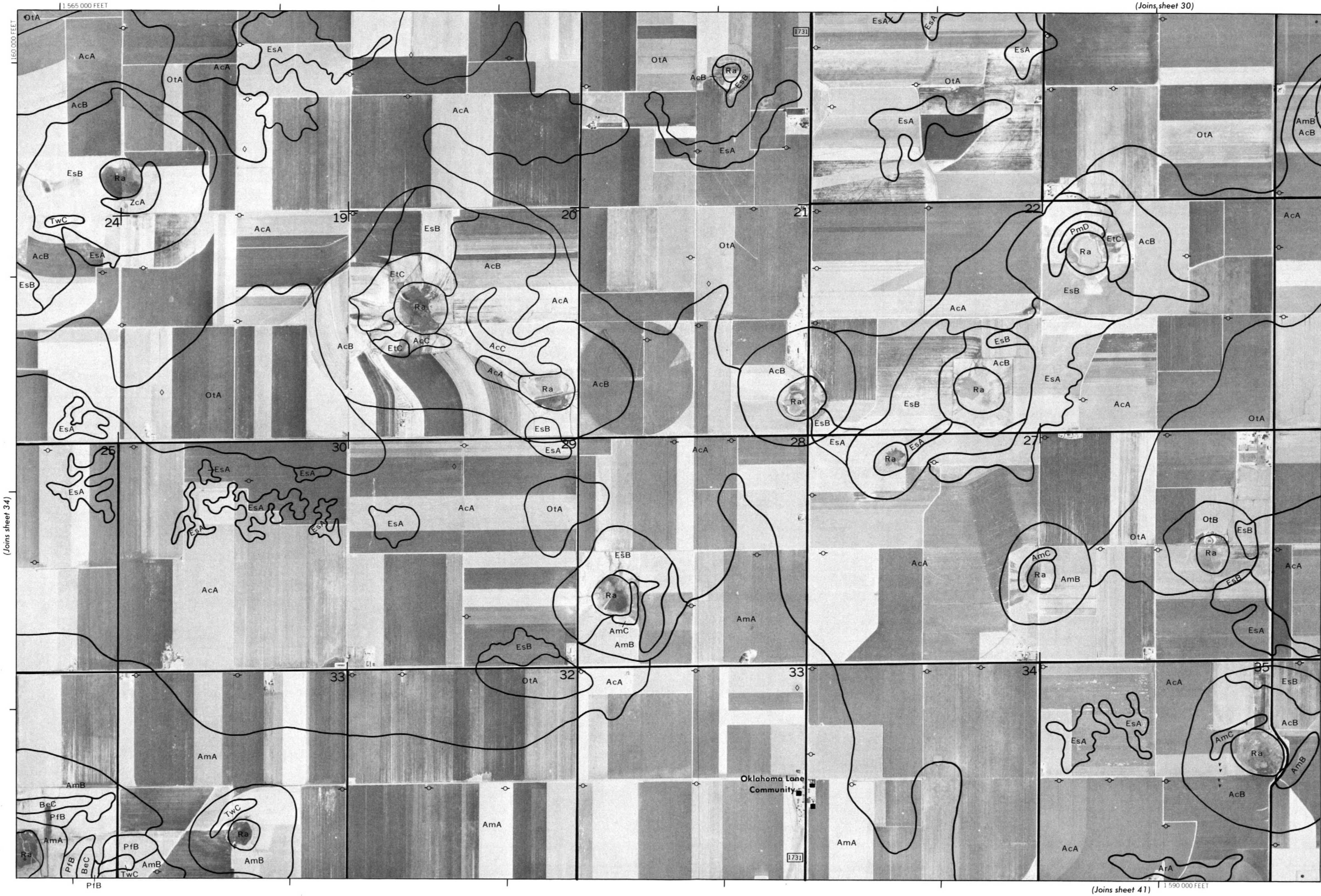
This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



35

N

Scale 1:24000

2 Miles | 1 | ¾ | ½ | ¼ | 0

10000 Feet | 5000 | 0

5000 | 4000 | 3000 | 2000 | 1000 | 0

PARMER COUNTY, TEXAS NO. 35

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.


36
N
(Joins sheet 31)
(Joins sheet 35)
(Joins sheet 37)
(Joins sheet 42)
2 Miles
10 000 Feet
Scale 1:24 000
1 620 000 FEET
160 000 FEET
145 000 FEET
1 595 000 FEET
20
21
22
25
27
28
33
34
36
3
4
145

37

This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

38

N

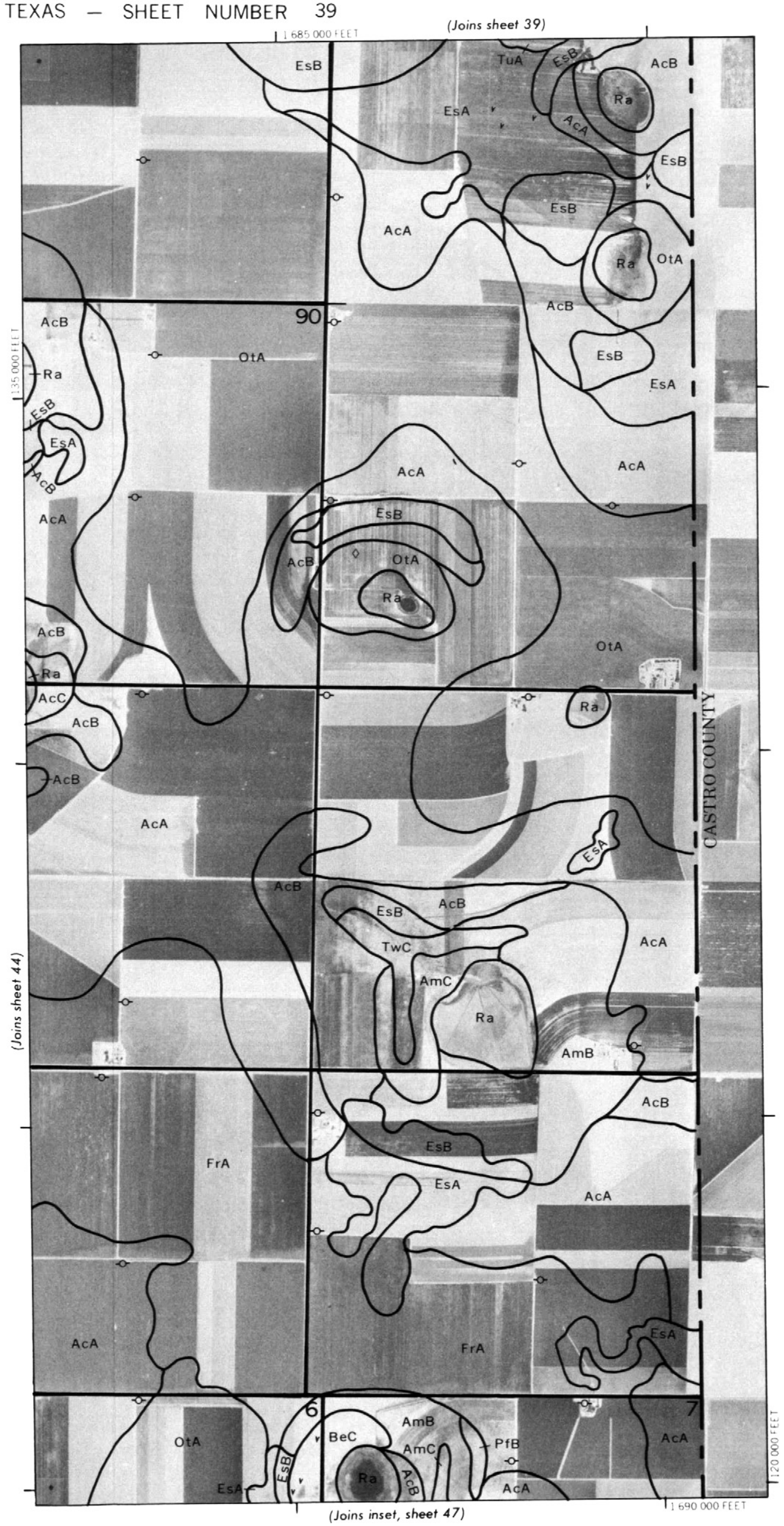
Scale 1:24 000

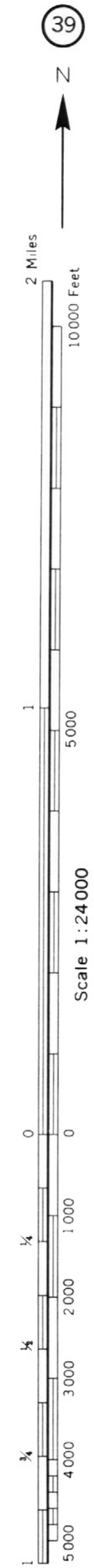
2 Miles

10 000 Feet

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 38





PARMER COUNTY, TEXAS NO. 39

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

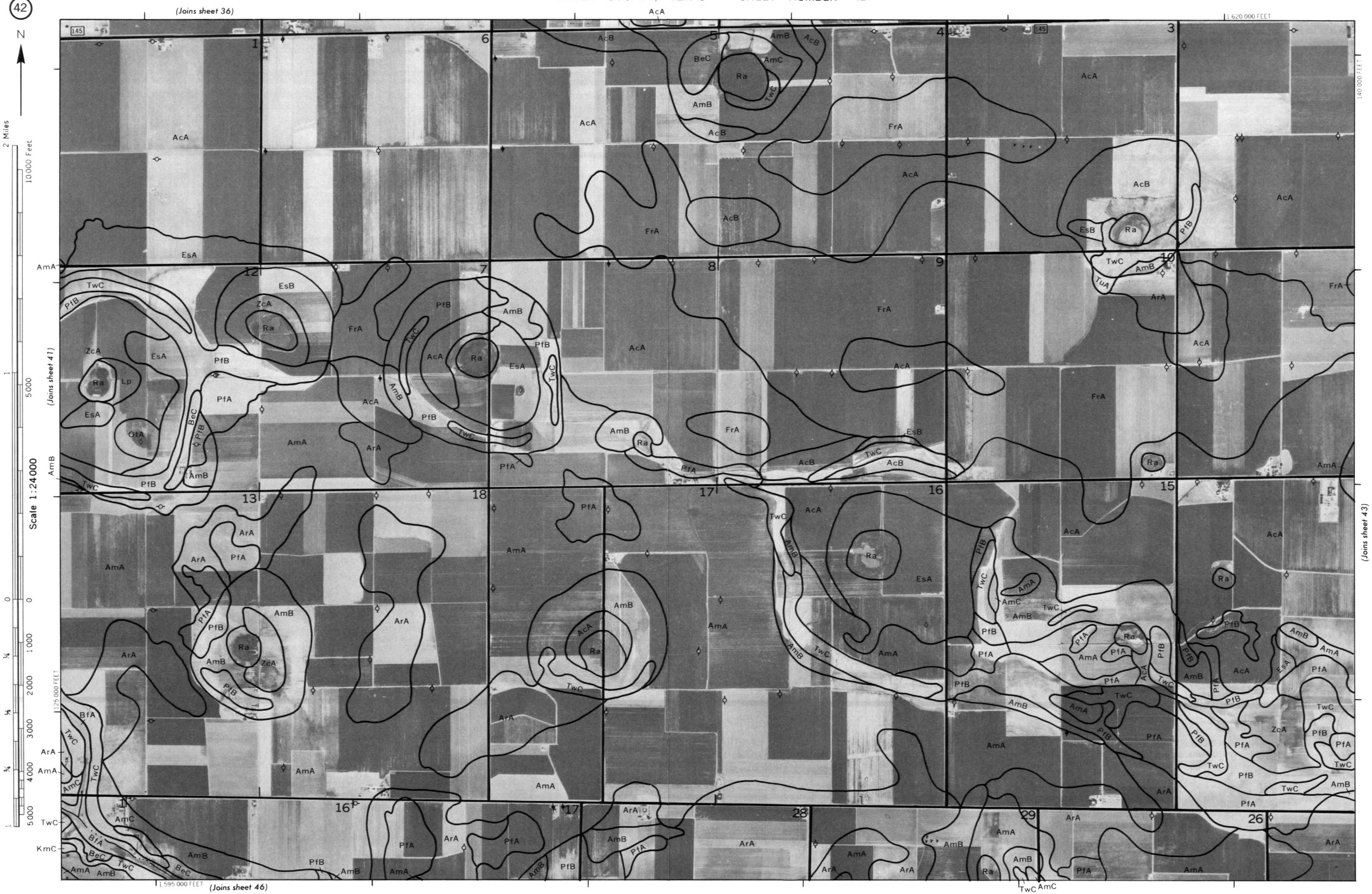
2 Miles
10 000 Feet
1
5 000
0
0
1000
2000
3000
4000
5000
Scale 1:24000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

41

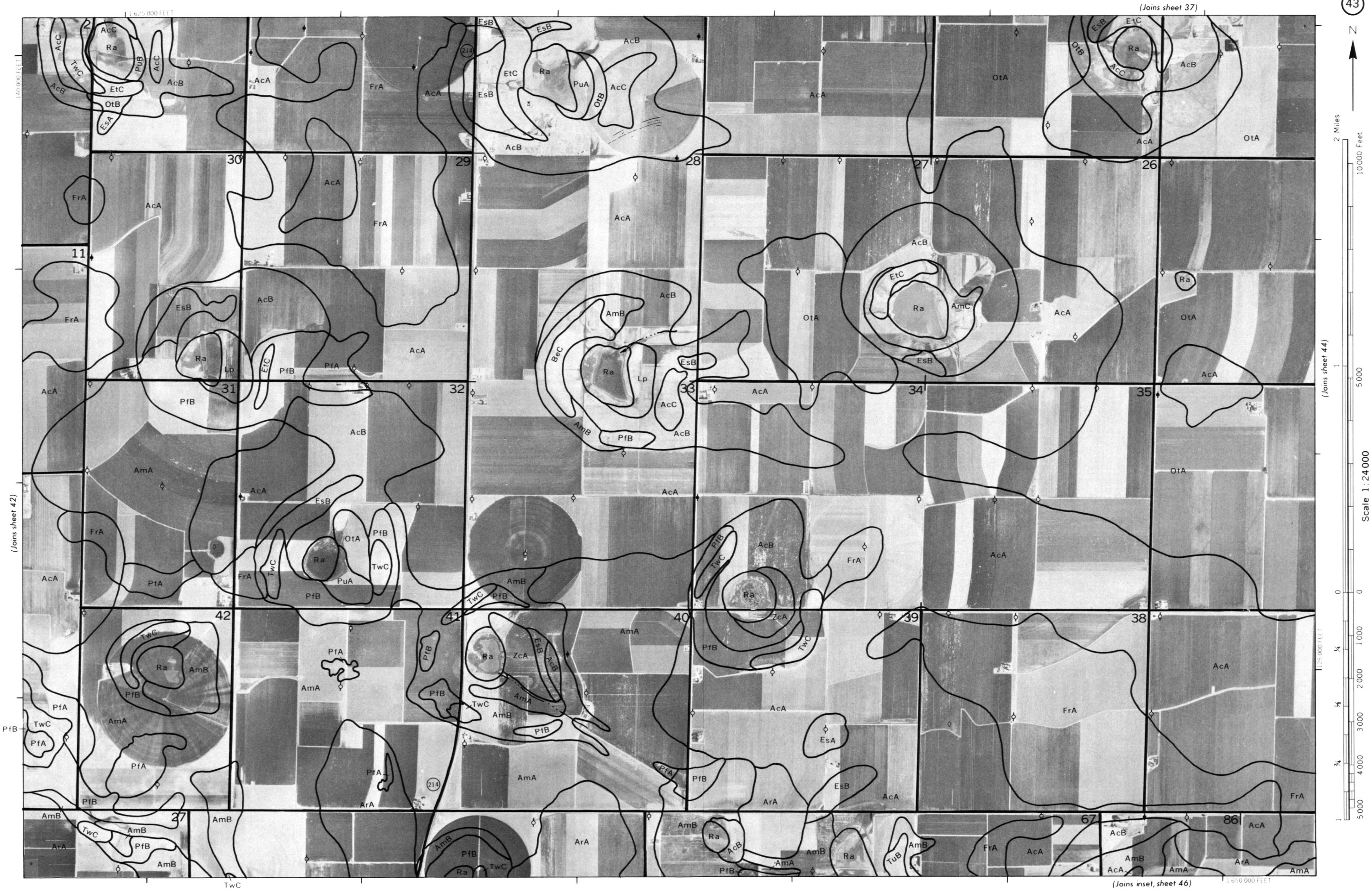
PARMER COUNTY, TEXAS NO. 41

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



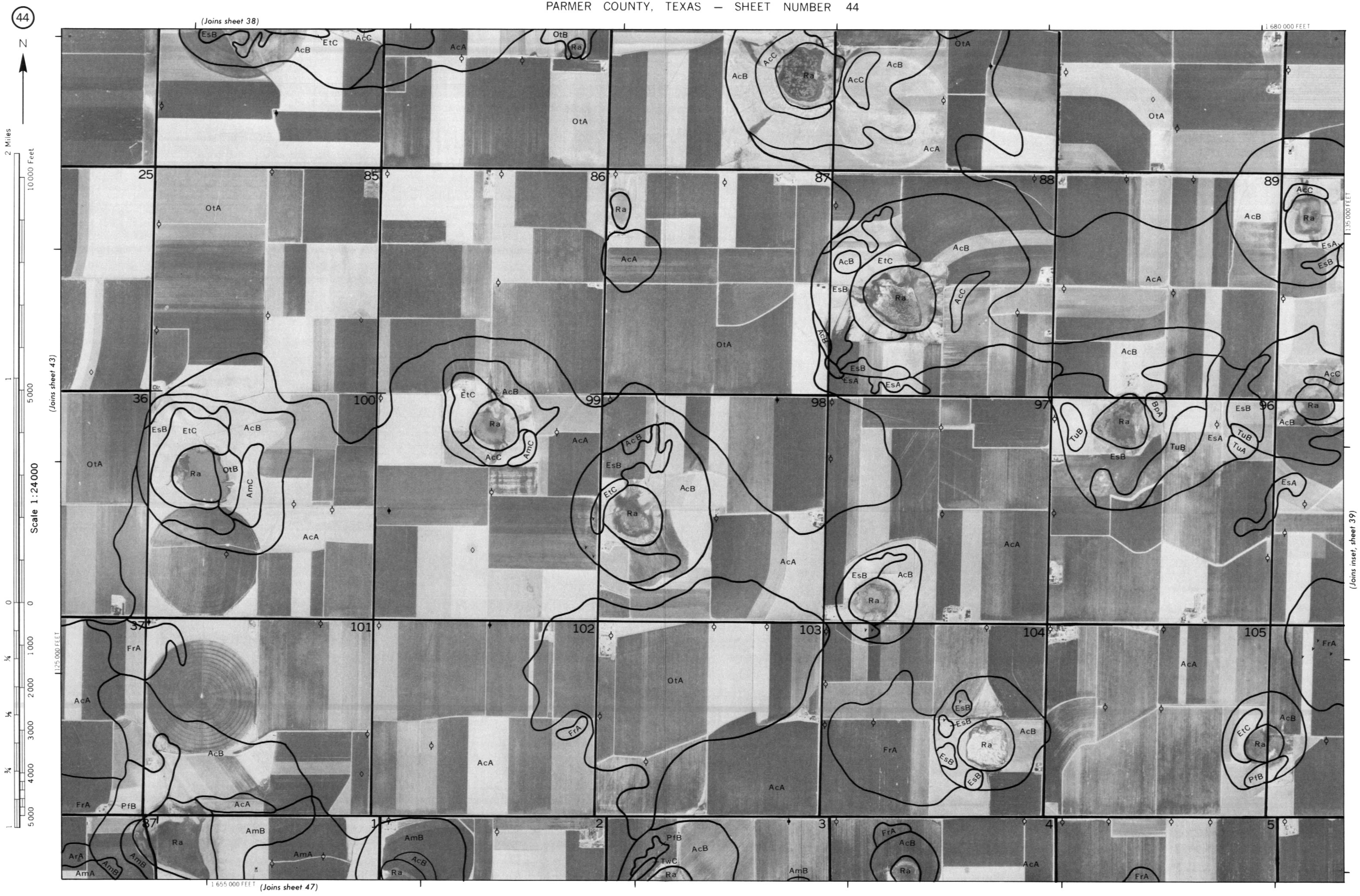
This map is compiled on 1974 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 42



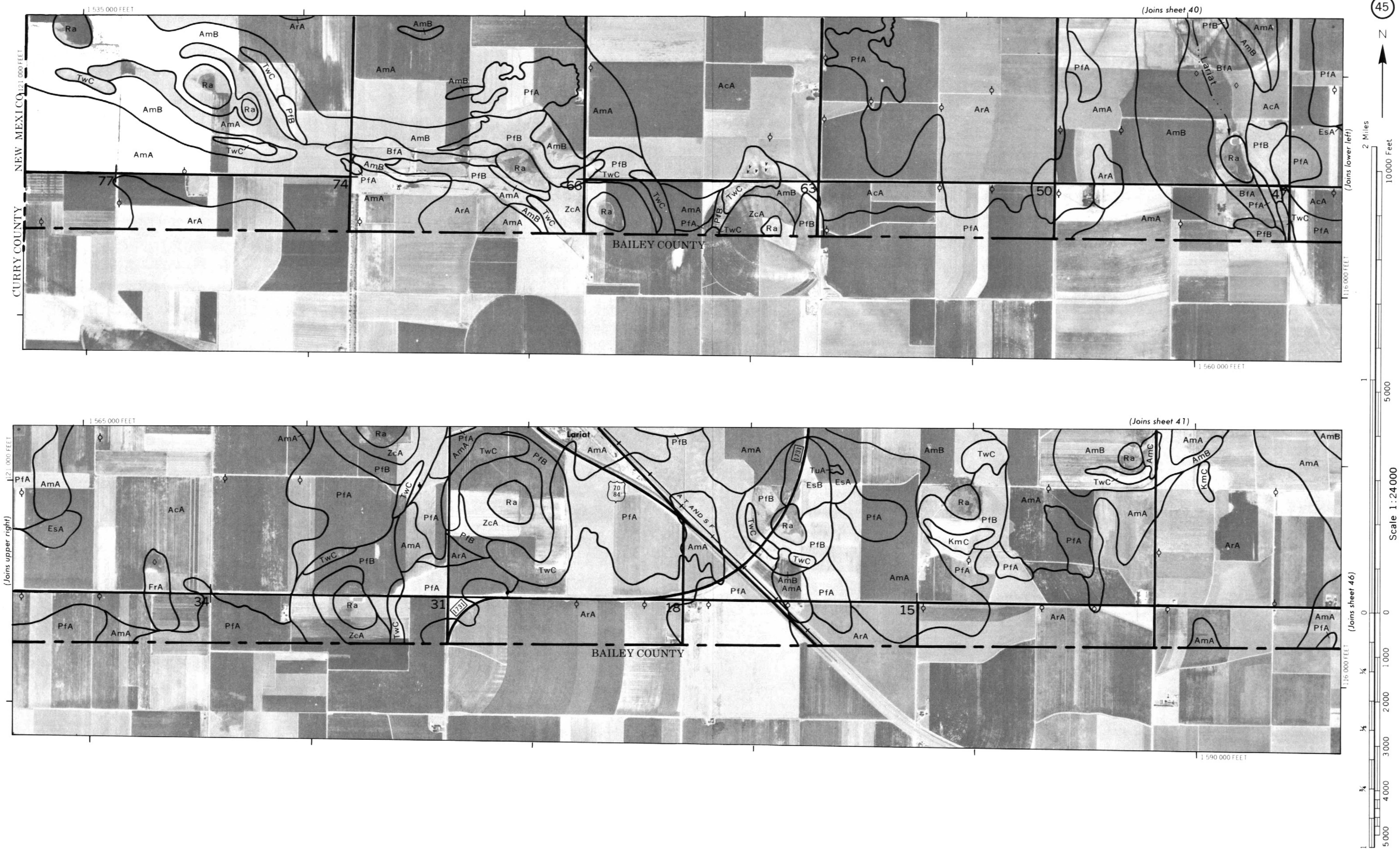
PARMER COUNTY, TEXAS NO. 43

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 44

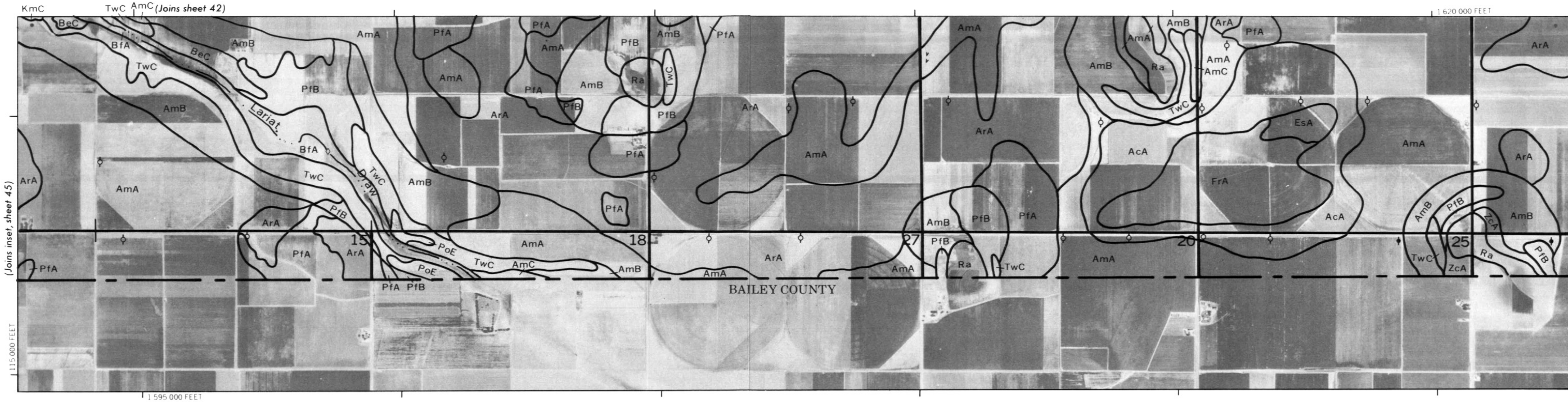


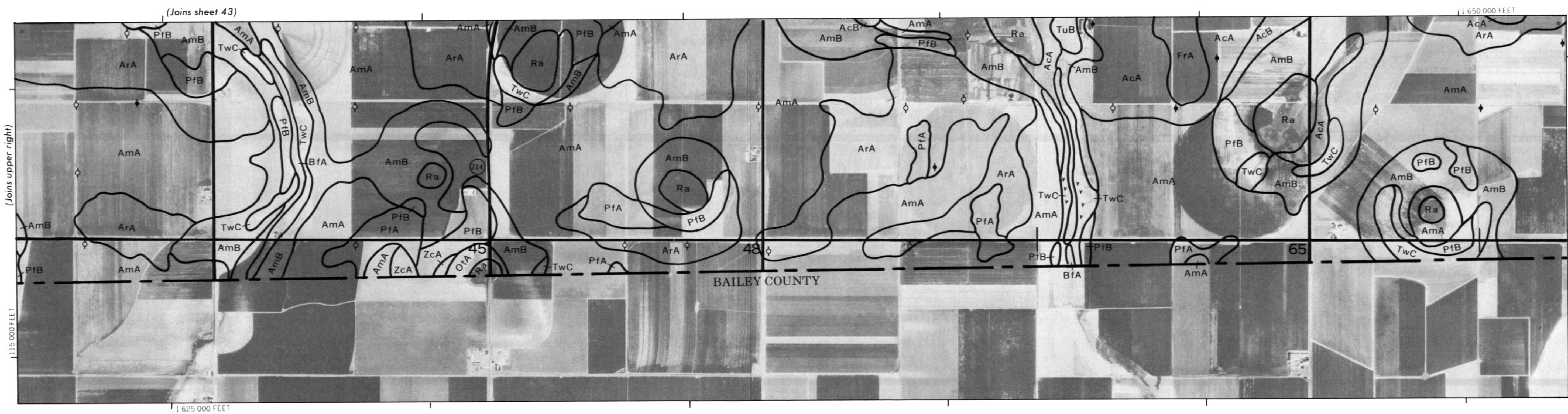
PARMER COUNTY, TEXAS NO. 45

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

46

N





Scale 1:24 000

2 Miles

10 000 Feet

1 ½ ¼ 0

5 000 1 000 2 000 3 000 4 000 5 000

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

PARMER COUNTY, TEXAS NO. 46

PARMER COUNTY, TEXAS NO. 47

This map is compiled on 1974 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.